Pit and Quarry

SAND - GRAVEL - STONE
CEMENT - LIME - GYPSUM

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Pit and Quarry

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YOUR COSTS AND PRICES

UNIT costs in general and within certain limits vary inversely with the volume of production. This is due to the fact that the so called invariable overhead charges do not follow changes in the volume of production. Of the three elements of cost, overhead, labor and, material overhead contains some items, such as supplies, that can be controlled in relation to the changes in the production schedule. In a large measure overhead costs are made up of what are appropriately termed fixed charges such as taxes, insurance, depreciation and in many instances interest. These items are fixed largely by the investment in plant, machinery, etc., and are nearly independent of the volume of business done.

Taxes are determined by the demands of public finance without respect to the monetary financial condition of the taxpayer. If we excuse the error of terming fixed an item which displays an irresistible tendency to increase, we may safely say that taxes are the most fixed of all charges. Depreciation may be somewhat less on idle equipment, than on equipment in constant use, and this item of cost may respond to some degree to changes in the production volume. This saving is more imaginary than real. Idle equipment deteriorates from lack of use and lack of attention. Machinery does become obsolete whether in use or not. Depreciation can therefore be called a fixed charge. Some saving may be effected in insurance during slack periods if the value of the stocks on hand is reduced. But often this is not the case and even when a saving can be made it is in most cases negligible. So it is with many other elements of overhead cost. While these overhead expenses are not strictly speaking absolutely invariable but they are sufficiently fixed so that they cannot conform to the wide changes in volume of production that occur in the non-metallic mineral industries.

These facts are generally known. But what to do with the excess costs that accumulate during subnormal production still continues to be a troublesome problem. Since the depression of 1921 and the period of recovery that followed, economists have given a great deal of thought to the subject. The fact did develop that the period of recovery was prolonged because of the difficulty of getting costs down to a basis where prices could be established at which materials could be moved. The overhead items were not the only ones to blame nor the only ones to suffer.

The first step was to cut the high priced inventories to a point where the material could be sold. This, however, was not sufficient. The cost of new production had to be reduced before material could be turned out at a price in line with the reduced demand. And this was a long and painful operation, owing to the excessive overhead charges in most industries. A scaling down process was found to be necessary, and the lesson learned by many as this scaling down process advanced was that some provision must be made for taking care of the excess costs resulting from decreased production in some other means than by loading it onto top production at a time when it is less able to carry the load. Decreased production may result from various causes but, whatever the cause, the net result is usually the same. Costs go up at a time when in order to get profit it is necessary for prices to come down.

There are times in every industry when, owing to the small volume produced and the resulting excessive overhead charge per unit to cover the "invariable" overhead items the current cost will lead to a price higher than the current demand will justify. The actual current cost of the product may be known to the third decimal place whether it will cover the cost of production. The actual cost of production is often entirely out of line with the price that can be obtained for the product. It is necessary, therefore, to have a price policy supported by some basis of price other than the actual or current cost of production.

Prices based on standard costs not only form a level for actual or subnormal conditions but form an additional reserve to help absolve the excessive cost which experience has shown will inevitably accrue in subnormal production. This does not mean the prices based on standard cost will eliminate loss during periods of subnormal production. Such loss very often can not be avoided. But prices based on standard costs will assist in bringing up a reserve that will in part at least absorb such loss when it occurs. Standard costs must be based on actual cost. This can not be computed without a careful study of what the actual cost has been in the past under varying conditions. But if carefully computed and constantly held in check, standard or normal costs furnish a basis of prices determination which cannot be supplied by actual costs.

What is the capacity of your plant at normal production? What are your actual costs at that rate of production? The unit current cost thus established would be the basis for the standard or normal cost to be adopted in determining selling price. This standard cost must necessarily be somewhat higher in order to provide for the excessive cost that will accumulate during periods of decreased production. How much higher is one of the vital questions in determining standard and normal costs. In the first place it is necessary to know the actual effect on cost of changes in the volume of production. In general the cost goes up as production goes down but the exact extent of such changes with respect to your plant is to be determined. The overhead cost for a period of years covering all the varying conditions of production should be studied. By a careful study of distribution of overhead costs you can spread your total expenses on a wider basis of standard costs with a resultant increase in net profit on your operations as a whole.

ARE YOU GOING HALF WAY?

LITTLE can be gained by overlooking or wilfully hiding the fact that 40 or 50 years ago many employers in this country were practicing unscrupulous methods and holding to domineering attitudes with respect to their employed personnel. Child labor was employed, to the detriment of everyone, and 16-hour sweat shops did exist. That all this was and is being grossly exaggerated by social reformers, socialists, and others is also unquestioned, but the fact remains that there was a time when certain divisions of "labor" had a just complaint against their respective divisions of "capital." Nor is the inference to be allowed that the industrialists of today are a flock of white-winged angels.

But any man with a fair degree of intelligence must admit that the industrialists—the "capitalists," so to say—have learned a great and important lesson during the past 25 years. At the same time, we must also admit, the employees, or at least those who have fallen under the domination of organized groups, have gone backward as rapidly and as far as the employing class has advanced. Thus is labor and capital as far apart as ever, but with a complete reversal of positions.

This latter fact has been proved countless times and in numberless ways during and since the war, but none more clearly perhaps, than by the voluntary expressions of large employers recently gathered in convention at Washington. These employers, representing an accurate cross-section of the mental and moral fibre of the average American industrialist, said things in open meetings as speakers before convention groups that would have met with bitter hostility and consternation, 25 years ago. For one man, or any man, to address and advise any group on the desirability of high wage maintenance, the shortening of hours, and the introduction of expensive equipment merely for the benefit of the working man would have, in 1900, been shocking if not quite impossible. But such statements were made by large employers— and there were 20 men to second and amplify the suggestions to one who might demur. In such fashion has the employing class advanced toward the goal of equitable and mutually profitable industrial relations. In our opinion, which is backed by very evident facts and clearly visible trends, "capital" has gone more than half ways in attaining this goal.

As has been stated in these columns previously, there are five major, fundamental princples for the development of contentment among industrial employees. These five principles are: 1—working conditions that promote the health of the employee; 2—wages on a level that will reduce turnover and promote efficiency; 3—wages at a level that will permit thrift on the part of the employee; 4—such wages as will impel cooperation; 5—unceasing education to the employee, both by precept and example, that a fair day's work will be rewarded by a fair day's pay.

All these factors point to the very evident need for wages to be as high as is consistent with the successful progress of the business. Just as the manufacturer or producer has learned that the public cannot be damned—that he must serve if he is to profit—so has he learned that consistent wages, regardless of attitude, is the best insurance for maintaining the kind of employees who will reduce production costs, increase volume, eliminate waste, elevate quality and give better value. Back in the days when Ford anonunced his 5-a-day minimum the average American manufacturer hadn't learned that lesson. But he has now, and having gone that far it is up to "labor" to catch up.

2. OLD MAN EXPERIENCE SAYS

Hurrying is not nearly so important as starting in time. The man who, sometimes, expects to be patted on the back for doing a rush job, really should have a swift kick because he didn't start when he should have. Plan carefully. Act promptly.

SIMPLICITY AND COMPACTNESS COMBINED IN LARGE CRUSHED STONE PLANT

By E. D. Roberts

ONE OF the leading producers of commercial crushed stone in northern Ohio is the Wagner Quarries Company. This company operates three different quarries within a short distance of the Sandusky where the main office is located. One of these plants is on the Pennsylvania Railroad, another is located on the New York Central Railroad while the largest and latest is on the Baltimore and Ohio Railroad. This third plant is the subject of this article because it is an excellent example of a very compactly arranged, efficient, large capacity crushed stone plant.

The limestone ledge, laid down by the accumulation of fossils in the bed of some prehistoric lake or sea, has not been subjected to any marked folding as it apparently lies in a level position. The entire plain is underlaid with a high calcium limestone with an overburden of only two feet. This overburden is stripped during the winter months. A number 2 Marion steam shovel is used in stripping. The material is thrown back until a ridge has accumulated large enough to lay a track for the passage of steam locomotives. The shovel then loads the material into cars which are hauled to the disposal pile. The limestone has been proven to a depth of 100 feet and 35 feet is being removed with the present cut.

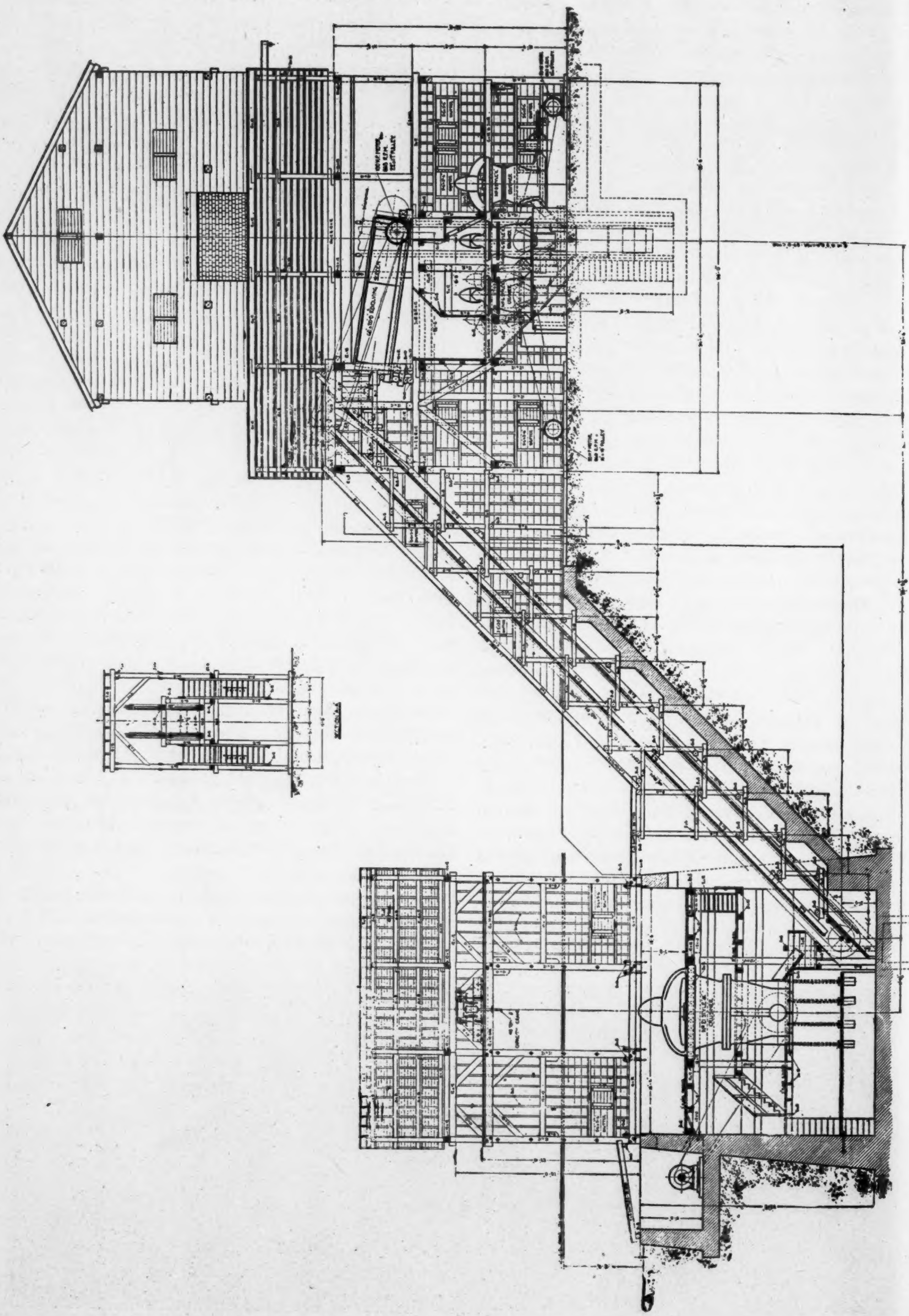
Four Loomis drills, two operated by electricity and two by gasoline, are used for drilling. Trojan, Hercules and Grasselli powder are used in blasting. Hardsocg and Chicago Pneumatic jack hammer drills are used. A number 92 Marion Steam shovel loads the rock into seven yard Koppel steel lined cars which are hauled in trains of six each by three 21 ton Vulcan saddle type steam locomotives over a 36 inch gauge track. These Koppel cars were installed last year and operated more than four months handling 4,500 tons of rock per shift without a derailment.

The arrangement of quarry tracks is simple and efficient. There are two tracks. One runs along the quarry face and the other runs through the crusher house and connects to the loading track at each end of the working face. Trains when loaded at the shovel move to one end of the loading track where they are switched to the plant track for the run to the crusher house. After being dumped, the trains move on through the crusher house and proceed to the other end of the quarry where they are again switched to the loading track. There is no track used for two way traffic, except the two short stub ends beyond the switches. The whole arrangement closely approaches a circular track in operating characteristics.

The cars are dumped at the crushing plant by an air hoist directly to a number 21 Allis-Chalmers jaw crusher. This crusher is a style K right angle right hand drive machine. The feed track, which runs straight through the crusher house at approximately the elevation of the quarry floor, is located 12 feet 9 inches from the centerline of the crusher and about seven feet above the rim of the spider. The feed floor and pit walls form a box of ample proportions in which the stone is permitted to form its own natural hopper. The crusher is fitted with chilled iron head and concaves and is set to crush to approximately seven inches and less. It is belted direct to a 200 h.p. three bearing slip ring motor.

The initial crusher discharges through a box chute directly to a 42 inch pan conveyor 111 feet centers, inclined at 45 degrees. The pan conveyor

South Elevation of Plant Taken from Quarry Face



Sectional Side Elevation of Primary and Secondary Crushing House.

discharges into a 60 inch by 20 foot scalping screen over the seconding crushers. This scalping screen is so arranged that three separations are made. The first twelve feet of the screen is fitted with 2½ inch perforations and the material passing these perforations is chuted directly to a 42 inch bucket elevator that feeds the sizing screens. The last eight feet of the scalping screen is fitted with 4 inch perforations and the material passing these perforations is fed to a battery of number 6 Allis-Chalmers crushers. The oversize material is fed to a number 8 Allis-Chalmers crusher. There are three number 4 Allis-Chalmers crushers, opposite the number 6 crushers, arranged to take the oversize material from the sizing screens. The number 4 crushers are set for 1½ inch stone, the number 6 for 2 inch stone and the number 8 for 3½ inch stone.

The grouping of the secondary crushers is unusually compact but ample room has been allowed around each machine for inspection and repair. The arrangement of the scalping screen and the secondary crushers has proven to be very efficient in this plant. Approximately thirty per cent of the product from the initial crusher passes through the 2½ inch holes, thus relieving the secondary crushing units of a considerable tonnage. The balance of the material is reduced to such size that only a small percentage of it need be returned for re-crushing. Hence, the bucket elevator and the sizing screens are relieved of a large circulating load and the cost of elevation is a minimum.

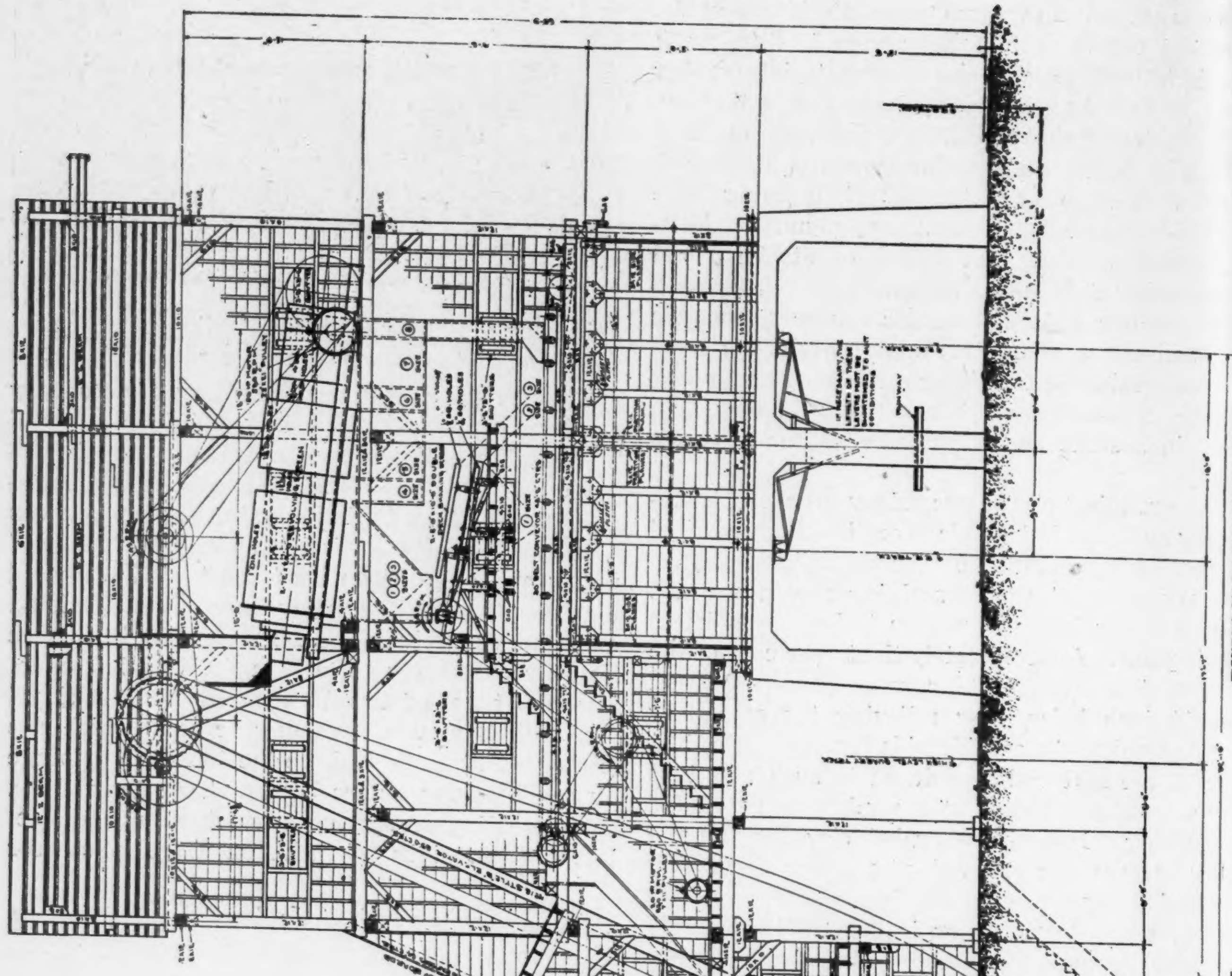
Each secondary crusher is belted direct to its individual motor. The number 8 crusher is driven by a 125 h.p. sychronous motor. This motor is purposely larger than the power requirement of the crusher so that the surplus capacity can be utilized for power factor correction. The number 6 crushers crushers are driven by 50 h.p. motors while the number 4 crushers are driven by 25 h.p. motors. The pan conveyor and scalping screen are driven by a 100 h.p. motor with the screen belted from one of the conveyor countershafts.

Quarry Face with Shovel and Drills Operating

The product of the entire battery of secondary crushers as well as the minus 2½ inch material passing the scalping screen perforations, is elevated to the sizing screen house in an Allis-Chalmers 42 inch bucket elevator 89 feet between centers. This elevator is fitted with a 72 inch head pulley and extra large head shaft with increased diameter through the pulley hubs. The belt is an extra heavy twelve ply rubber elevator belt. The elevator discharges through a dividing box chute into a battery of two 72 inch by 24 foot closed end Allis-Chalmers revolving screens which are located about 20 feet above the top of the storage bins. These screens are fitted with tandem jackets, an interesting arrangement which insures the removal of the minus 1½ inch stone from the coarser sizes.

The minus one inch stone from the first jackets of the revolving screens passes by gravity to two 5 by 10 feet Allis-Chalmers compensated type shaking screens. The upper decks of these screens are fitted with tank steel plates and the lower with wire cloth. These screens handle the feed from the 72 inch screens without overcrowding and deliver a clean well sized product. The rejections from the revolving screens are carried back on a

Shovel Loading Cars on Track



Sectional End Elevation of Secondary Crusher House and Sectional Side Elevation of Screen House.

30 inch belt conveyor to the secondary crusher house where they are re-crushed by the number 4 crushers. This conveyor and the two shaking screens are driven by a 20 h.p. motor. The 72 inch revolving screens and the 42 inch bucket elevator are driven by a 150 h.p. motor. The motors are of Allis-Chalmers manufacture.

There is a bin storage for 800 tons. There are eight bin compartments, each fitted with two 20 by 20 inch clamshell bin gates. The bins are located over shipping tracks and are also equipped with side spouts for loading trucks. Each truck load is weighed on Fairbanks Morse platform scales. The walls of the bins are constructed of wood while the supporting tiers and floors are concrete. All of the buildings are timber frame construction with wood sheathing and composition roofs. Considerable storing and reclaiming of stone is necessary and two Ohio locomotive cranes are used in this work. One of these cranes is a twenty ton and the other a twenty-five ton machine. By storing the smaller grades of stone when there is little demand for them, the company is able to take care of the peak demand for these sizes without re-crushing of the coarser grades.

The dust problem confonted the Wagner Quarries Company the same as it has many others but in this instance the object of removing the dust was to improve the working conditions in this plant. The dust removed is sold, however, to the Sandusky Portland Cement Company who operates a cement plant nearby. The fines are removed from the chips by two vibrating machines. Sixteen dust collecting units manufactured by the Dust Recovering and Conveying Company are installed in the plant and practically every particle of dust in the air is collected.

Only seven men are required to operate the plant including two loaders and one electrician. The total force in the plant and quarry is about 35 men. The production averages daily more than one hundred tons per man which in itself is an excellent index of the efficiency of this compact and simple but large crushed stone plant. Mr. Fred Zeck is general superintendent in charge of all the plants of the Wagner Quarries Company. Mr. W. G. Sprow is general manager for the company.

View of Crushing, Bin and Receiving Houses

A Glass Substitute

Pollopas, a transparent colorless brilliant solid resembling rock crystal or flint glass, is a condensation product of urea and formaldehyde. It is being used in Great Britain as porthole glass. Experiments to use it as a windshield are being made because it is claimed it would be almost impossible for a person to cut himself. The material has a strong resistance to shock. At present Pollopas is too easily scratched. It chars at about 200 degrees centigrade but does not burn or melt. It is slightly absorptive.

Fused Aluminous Cement

Clay rich in silica is heated to the fusion point with the addition of silica dissolving or silica combining substances which reduce the SiO_2 content at least to the proportion corresponding to that for fused aluminous cement so that it may be used in the usual maner in the cement industry. F. Krupp (D. R. P. 437, 242).

Another View of Drills and Shovel Working in Quarry

MORE LIMESTONE TONNAGE BEING PRODUCED BY UNDERGROUND MINING METHODS

A MARKED tendency toward producing larger tonnages of limestone by underground mining methods instead of by the old established quarrying practices is very evident in the United States, the Bureau of Mines, Department of Commerce, points out. In the course of six months' time during which the subject was investigated by the Nonmetallic Minerals Experiment Station of the Bureau, at New Brunswick, N. J., the number of underground limestone mining projects was doubled. Some of these limestone mines are quite large, the maximum daily production from a single mine being 3,500 tons.

The enormous and constantly increasing demand for limestone to supply a multitude of uses is a remarkable feature of the mineral industries, states J. R. Thoenen, consulting mining engineer, Bureau of Mines, in a report on the subject. As approximately 130,000,000 tons of limestone are produced annually in the United States, it is not surprising that deposits at or near the surface are gradually being exhausted and that less advantageous supplies are being worked. Quarries are becoming deeper and wider year by year, and in many places the volume of overburden that must be removed to allow open-pit work is tremendous. Quarrymen are also gradually learning how expensive it is to sort and clean stone from a deposit overlain by poor material.

As such conditions confront the limestone industry, the natural tendency is to seek some modification in method whereby the handicaps of increasing cost may be met and overcome. Operators, some of them unwillingly, have been forced to conclude that underground work in drifts and tunnels is the most logical solution of the problem. The unwillingness of some is largely due to unfamiliarity with mining and to the unfounded fear that costs must increase and dangers multiply when mining is undertaken.

The advantages of underground limestone mining are summarized by Mr. Thoenen as follows: Removal of large masses of overburden is avoided. A mine may be operated the year round, irrespective of weather conditions, thus affording steady employment to workers and promoting contentment in the personnel and a low labor turnover. Under certain conditions storage facilities can be provided underground more easily than on the surface and without deterioration of the product. The surplus produced when the demand is slack can be stored in anticipation of peak demands. The clean stone produced at mines often commands a higher price than quarried stone. In fact, cleaning, at considerable expense, is often necessary to make the quarried product salable. Moreover, the limestone strata in mines are not exposed to the action of frost or water or mud washed from a clay overburden. For fluxing, mined stone is cleaner both in lump and fine sizes than quarried stone. A mine can be advanced to property lines regardless of such factors as extent of overburden, dip of strata, cavities, and surface conditions. Moreover, mines can be worked within city limits, where quarrying might be dangerous or be forbidden by ordinances.

The disadvantages of underground limestone mining may be thus summarized: Some means of ventilation must be supplied to carry off fumes from explosives and furnish fresh air to workers. There is danger from falling rock. More fines are produced than in a quarry. The type of labor required is more skilled, and therefore more expensive, than quarry labor. Costs are in general higher than for quarries, but the difference may be counterbalanced by the higher quality of the product.

Limestone mining is a comparatively young but rapidly growing industry. Mining methods are applicable to all deposits underlying overburden that is too heavy to be removed or handled by open-pit methods. Factors that make mining possible are the presence of enough stone to warrant the expense of development, stone of a grade to satisfy market requirements as to quality and price and also strong enough to make adequate pillars. Strong roofs formed either by the stone itself or by overlying stratum are requisite. Various methods of mining adapted from coal-mine, metal-mine, and open-quarry practice are in use as well as combinations of all three methods. The same statement applies to the placing of drill holes. The types of equipment used underground are much like those in use at open quarries, except that churn drills can not be used.

There does not appear to be any greater danger in limestone mining than in metal mining if work is properly planned and carefully supervised. As many quarrymen lack information on mining methods, limestone mines need more skilled men and better technical direction than quarries. Although average mining costs are higher, many individual mines operate at lower cost than many open quarries. The choice between mine and quarry depends upon local conditions, and a decision should be made only after careful study.

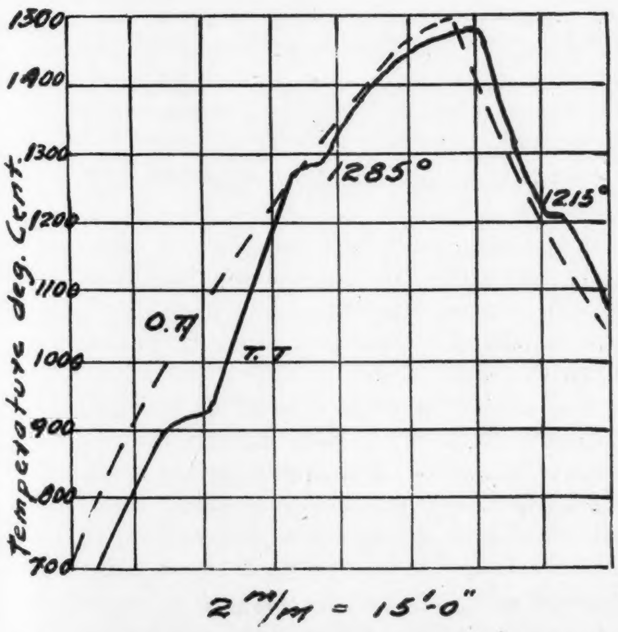
Road Building Progressing in Greece

Road building in Greece is being carried out as the country's limited financial means permit, which is gradually increasing motor trucking. Many of the remoter districts still depend on ox carts and horse drawn wagons for transportation.

STUDY OF THE REACTIONS IN BURNING CRUDE CEMENT MIXTURES

By Dr. Walter Dyckerhoff

A SAMPLE of crude cement mixture was taken in a mill during the course of operation. The analysis of this mixture gave the following results:—lime 65.65 percent, silica 20.56 percent, alumina 6.54 percent, iron oxide 3.19 percent, magnesium oxide 1.94 percent, sulphur trioxide 1.71 percent, and alkalies 0.41 percent. This mixture was employed in establishing a certain series of heating curves, all of which were very much like the curve which is shown in the graph. The dissociation of calcium carbonate, which took place at a temperature of 910 degrees C, served to retard the rise of the crucible temperature. A strong exothermic reaction followed directly after this. The crucible temperature exceeded the kiln temperature by approximately forty degrees C. As has been indicated in earlier studies, bicalcium silicate and monocalcium aluminate are formed, and due to the close similarity of the properties of iron oxide with those of alumina, it must also be assumed that a lime-iron oxide compound is also formed.



This exothermic reaction is interrupted at a temperature of 1,285 degrees C. by a melting process. The crucible temperature is considerably lowered under the kiln temperature and again reverts into its normal state which is somewhat below this point. Now the curves run parallel up to a temperature of 1,450 degrees C, and this refers to the temperature as well, which is considered as the sintering temperature.

In one case the heating progressed up to a temperature of 1,505 degrees C without any further thermal effect being indicated after melting at a temperature of 1,285 degrees C. About fifteen curves were drawn for temperature rises up to 1,450 degrees C while the experimental conditions were varied, most particularly the rapidity of the temperature rise, in order to exclude accidental changes as far as is possible. There was no thermal effect that could be detected in any case over the endothermal reaction at a temperature of 1,285 degrees C. Between the temperatures of 700 and 800 degrees C there was a clear indication of a small bend in the curve which corresponds to the decomposition of the clay into alumina and silica.

The current which was used in heating the crucible was turned off at a temperature of 1,450 degrees C and the drop in temperature was plotted in the form of a curve. This curve yielded information regarding a holding point at a temperature of 1,215 degrees C. Molten masses also congealed at a temperature of 1,285 degrees C. If the current was turned on again, then the crucible temperature rose gradually, as the exothermic reaction could not naturally set in a second time. But there was again a retardation in the rise in temperature at a temperature of 1,285 degrees C, which was noticeable in the partial melting of the mass. The cooling curve again showed congealation of the mass at a temperature of 1,215 degrees C.

It was concluded from this that we are concerned here with a melting process. For control purposes heating at a temperature of 1,260 degrees C was broken off, and another heating was interrupted at a temperature of 1,300 degrees C. The difference between the two products was markedly great. In the first place a soft melt of yellowish color was obtained, which was brittle and of very slight compactness, and in the second case a darker and harder clinker was obtained. The latter was much more compact, being strongly contracted, than the first and looked just like the ordinary clinker that is obtained in cement manufacture.

The microscopic examination of both products yielded information which came up to expectations. The principal portion of the mass consisted of crystalline matter, which was colorless and double refractive. The index of refraction was n=1.715. Hence the substance was beta bicalcium silicate. In addition thereto there were also dark masses which were amorphous, often isotropic and which could not be identified any closer.

The investigations of the author on former subjects of this character led him to follow through

Editor's Note: Translated from Zement, Volume 15, page 200.

accurately the burning process up to the melting temperature of 1,285 degrees C. The water contained in the cement slurry was evaporated at a temperature of 100 degrees C and between the temperatures of 700 and 800 degrees C the clay was decomposed. Then the carbonate of lime was decomposed at a temperature of 910 degrees C. Monocalcium aluminate was formed at a temperature of 1,000 degrees C and probably a calcium iron oxide compound as well. Bicalcium silicate was formed between the temperatures of 1,100 and 1,200 degrees C. The residual mass melted at a temperature of 1,285 degrees C. The crystals of bicalcium silicate were found as a solid phase in this melt. Hence, when we speak of the burning of a raw cement mixture up to the point of sintering, that is incipient fusion, then we must understand that this characterization does not apply to the actual process that goes on in the cement kiln. What really happens is complete fusion of a portion of the mass from which the cement is made.

Following the course of the cement burning process in a rotary cement kiln, which has been set aside in the mill for this purpose, yielded results which corroborate this contention. After the water had been driven out of the mixture, the raw mass had agglomerated together in the form of reddish-yellow balls. These lumps or nodules again disintegrate, as they progress further along in the kiln. At this point the product consists of a yellowish, soft mass, and then the carbon dioxide is evolved by the decomposition of the limestone. This process requires a considerable portion of the kiln for its completion. Thus in the case of a kiln with an over-all length of 50 meters, this stage of the burning was accomplished over a length of approximately 12 meters. Then the conversion of this soft mass into the dark hard clinker took place quite suddenly.

The nature of the heating curve which can be plotted for this process is essentially the same as that for the heating of a synthetic cement. The only difference is that in the case of the raw cement mixture used for this purpose the melting occurred at a temperature of 1,285 degrees C., and in the case of the synthetic cement it occurred at a temperature of 1,390 degrees C. This reduction in the melting temperature of approximately 105 degrees C. is, for the most part, to be assigned to the substitution of part of the alumina by iron oxide and in lesser degree to the action of alkalies and other ingredients contained in the technical mixture, all of which tend to reduce the temperature of melting.

If a heating curve is plotted for a burnt and ground cement, then it is found that the same endothermic reaction takes place in the cooling curve again at a temperature of 1,215, at which point the cooling is retarded. When the entire mass was melted, a clinker was again obtained from the cement powder.

As has been mentioned before, small cracks occur when the heating is continued to a temperature of 1500 degrees C. Heating curves on raw cement mixtures were established by Drittler and Jesser (Concerning Several Investigations on Sintered Portland Cement Raw Mixtures, Zentrallblat fuer Chemie und Analen d. hydr. Zement, 1910, page 71). These curves differ from the ones that have been described in this article.

R. Nacken (see Concerning the Reactions that Take Place During the Heating of Raw Cement Mixtures, Zement, 1920, numbers 6 and 7, and 8) has showed the unreliability of the investigations that were made by these two scientists. Nacken's investigations are the only ones that are accurate, as far as the author's knowledge goes, and are in good agreement with his own. Nacken carried out the melting process at a temperature of 1270 degrees C., while the author used a temperature of 1285 degrees C. This slight difference may very well be due to the variation in the chemical composition of the raw cement mixtures used in these separate investigations. Just the fissures that occurred in the material during the melting process were examined, and at a temperature of 1400 degrees C. such a phenomenon occurred again, but it was not further investigated. In spite of additional experimentation along the same lines and with the experimental conditions maintained exactly the same as in Nacken's case, and in spite of a large number of observations, the author was not able to establish this phenomenon during the heating of the raw cement mixture which he used in his tests.

In order to study the condition of the raw cement mixture after equilibrium had been established, the mass was heated to a very high temperature in the flame of the oxyhydrogen blowpipe. When examined in a thin layer, the material that is obtained under these conditions has an entirely different appearance than that of the ordinary sintered product. Long, fine needles with a very slight double refraction, partly colorless and partly yellowish in color, lay in a yellowish melt, which filled the intervening spaces between the needles. Approximately 90 per cent of the total mass consisted of these fine needles all of which showed the same optical properties.

These needles were composed of the compound, $8CaO.2SiO_2.Al_2O_3$. This was obtained from the microscopical examination of the substance. Equilibrium had thus set in, and the condition of the melt corresponded with the curve. Inasmuch as the chemical composition of the mixture lay in the neighborhood of the compound $8CaO_2.2SiO_2.Al_2O_3$, this substance must form the greater part of the mass. From the fact that observation told that a portion of these needles were yellow in color, it can be concluded that a portion of the alumina contained in this substance can be substituted by iron oxide.

Hence the optical picture of a molten preparation is entirely different from that of the normal portland cement clinker. It was therefore of particular interest and importance to determine just how far this marked change in the constitution of the product was connected with any change in its hydraulic properties. To this end, approximately two hundred grams of the clinker, were obtained with the aid of the oxyhydrogen flame. However the job of melting so large an amount of material was found to be so difficult and laborious, that it could be carried through to completion only in a single instance. The molten product was then ground to the fineness of portland cement and then its setting properties were examined. In addition thereto several samples were made for strength determinations, the proportions of these samples being three parts of a standard sand to one part of the cement. The tests were made in accordance to the standard methods accepted by the makers of portland cement in Germany. The strength figures that were obtained in these experiments are given in the following tabulation and are also compared with those that are obtained with a normal cement. Tensile Strength of the Mixture: One part of cement, three parts of standard sand, mixed in the standard way, all figures on the weight basis.

Nature of the storing conditions	Molten Portland cement	Sintered Portland cement
7 days in water	15.5 kg. per sq. cm.	25.2 kg. per sq. cm.
28 days in water ...	21.5 kg. per sq. cm.	29.6 kg. per sq. cm.
2 months in moist air	30.5 kg. per sq. cm.	33.7 kg. per sq. cm.

	Molten Portland cement	Sintered Portland cement
Time of Set	Minutes	
Beginning	160	150
End	370	350
Constancy of volume on testing in cold water...	constant	constant
Cooking test	good	good

It is evident from these figures that there is no hydraulic difference between the molten and the sintered cement. On the other hand the strength of the cements varies and particularly at the beginning of hardening it will be found that the strength of the molten cement will be less than that of the sintered cement.

Hence we have established two fixed points in the determination of the constitution of portland cement clinker:

The first point is located at a temperature of approximately 1300 degrees C., at which point the clinker consists of 60 per cent of bicalcium silicate.

The second point is located in the neighborhood of 1800 degrees C., at which point equilibrium sets in within a short time, and the product consists of approximately 40 per cent of the compound $8CaO.2SiO_2.Al_2O_3$ or of a similarly composed iron compound.

Hence the temperature of approximately 1450 degrees C, at which portland cement is burnt in practice, lies somewhere half way between these two points. The conclusion may therefore be drawn from this fact that it will never be possible to establish a single formula which will define the chemical nature of the main constituent of the clinker. Its composition will depend on the status of the equilibrium, which may exist at any moment, between both these fixed points and it will also be completely dependent of the temperature and the duration of the heating process. The higher the temperature to which the mass is heated and the longer it is maintained at this temperature, the further along will progress have been made to the point of final equilibrium.

Bicalcium silicate is, however, the carrier of the main constituent of the clinker. This compound is always formed when a mixture of lime and alumina is heated. The fact that it is a comparatively easy matter to burn cement, in spite of the complexity of the system, which is far greater, as may be seen from the information that has been given in this article, than has generally been appreciated, can only be explained as being due to this phenomenon.

The mechanism of the institution of a condition of equilibrium can be studied in the light of experience which has already been gained on this subject. Thus the bicalcium silicate at first absorbs lime in a solid solution, then new compounds are former, such as the tricalcium silicate and $8CaO.2SiO_2.Al_2O_3$.

These new structures have not yet been indicated in a synthetic clinker, which was burnt at a temperature 110 degrees C. in excess of the melting point of the residual mass. The formation process was not carried further than the first stage which was the absorption of lime. Under like conditions of temperature, which here is 110 degrees in excess of 1285 degrees C. or 1385 degrees C., and in accordance with the duration of the heating, it may be assumed that the highly basic compounds do not form even in the technical clinker. However, it was also found that the process had not taken place in the case of preparations which had been treated for safety sake up to a temperature of 1450 degrees C. The temperature is moreover only very low and it is only at considerably higher temperature that the formation of highly basic compounds begins to take place at speeds which are of importance from a technical and practical standpoint.

The thermal study of the clinker also reveals the fact that the principal constituent of portland cement clinker is a beta bicalcium silicate, which has absorbed considerable quantities of lime which are held in solid solution. The optical examination of the clinker corroborates this statement. Alite, which is the name commonly given to this principal ingredient of cement is directly slaked, shows slight double refraction and a high light refraction. The crystals are rhombic and their optical character is positive. These observations agree with all of the microscopical clinker investigations which have been made public up to the present time. Most of the measurements have been corroborated by the author. The conclusions indicate that neither tricalcium silicate nor the compound, $8CaO.2SiO_2.Al_2O_3$ form Alite, for the crystals of these two compounds are optically negative.

In order to make sure that the deductions reached were correct, a test was made with a preparation which was subjected to the action of the liquid residual melt for considerably longer than usual time. The mixture was heated for half an hour at a temperature of 1450 degrees C. and then for another hour and a half at a temperature of 1300 degrees C., which means at all times at a temperature in excess of the melting point of the residual mass. A powder prepared from this clinker showed principally colorless crystals whose optical constants agree with those of beta bicalcium silicate. Individual crystals of lime were imbedded in the mass. The rest of the picture, which was mostly brown in color and parts of which showed a very high degree of double refraction, could not be identified, for up to the present time there have not been available any exact methods for the investigation of lime-iron oxide compounds, as well as the ternary compounds of the system, lime-alumina-iron oxide.

In spite of the duration of the heating, the "Alite" portion of the clinker always consisted of bicalcium silicate enriched with lime. The conclusion was accordingly drawn that neither tricalcium silicate nor the compound $8CaO.2SiO_2.Al_2O_3$ can be formed during the technical burning of cement.

The obsorption of lime by the bicalcium silicate assumes a very high importance in the manufacture of portland cement. This is shown by the following experiment. A setting test was made with the aforementioned mixture, consisting of 65 per cent of lime, 30 per cent of silica and 5 per cent of alumina, which gave a product after burning, containing approximately 85 per cent of bicalcium silicate. The results of this test were normal. The strength of the set cement was, however, considerably below that obtained with technical or synthetic cements. Hence it is seen that beta bicalcium silicate is itself a hydraulic binding medium, but its propertiés are considerably improved when it is first allowed to absorb lime.

The crude mixture must, therefore, be prepared in such a fashion that an excess of lime always remains behind in the residual mass. To this end the composition of the crude cement mass must be shifted as far as possible over the $2CaO.SiO_2.3CaO.Al_2O_3$ line in the ternary diagram towards the lime angle, or at least above the line $2CaO.SiO_2$-$3CaO.Al_2O_3$. No excess of lime will be present in the residual melt on the side of this line turned away from the lime apex, as it is combined with stable aluminates. When this line is overstepped through the formation of mixtures that are richer in lime, then free lime remains in the residual melt, for the high lime containing compounds $3CaO.SiO_2$ and $8CaO.Al_2O_3$ are not formed at the temperatures that prevail in the process. This lime is either partially or entirely absorbed by the bisilicate.

The raw mixture is pushed so close to the lime-silica line in the field limited in this manner that it enables the raw material to hold as much silicate as possible and to become so high in lime content that it counteracts the absorptive capacity of the bicalcium silicate for lime. The distance that is maintained from the lime-silica line is such that the quantity of the residual melt formed is sufficient to surround all the silicate crystals. This factor is particularly dependent on the manner of preparing the raw materials. The more thoroughly the component parts are mixed together, the more likely it is that a uniformly composed residual melt will be obtained and hence the formation of fissures in the cement block is avoided.

In accordance to what has been said above, the highest strength is to be expected in that portion of the field which lies in the neighborhood of tricalcium silicate. O. Schott (see Dissertation, Heidelberg, 1906, page 108) actually found that the best strength obtained with his clinker, which was composed of 68.2 per cent lime, 23.7 per cent of silica and 8.5 per cent of alumina, was 41 kilograms per square centimeter after 28 days. The place in the diagram, which corresponds to this composition, fulfills the given conditions.

In order to differentiate more accurately between the action of the various components of the residual melt, a mixture was made which contained the four principal ingredients of the raw mixture used by the author in the same proportions. On the other hand no impurities, such as alkalies, sulphur trioxide, magnesi and the like were present in the mixture. The mixture thus consisted of 65.65 grams of lime, 20.65 grams of silica, 6.54 grams of alumina and 3.19 grams of iron oxide. The heating curves determined with this mixture had the same shape as that which was obtained with the raw cement mixture, with the exception that in this case the melting point of the residual mass was just 1300 degrees C., instead of 1285 degrees C. in the case of the raw cement mixture. The holding point in the cooling curve was 1240 degrees C. in place of 1215 degrees C. Hence the lowering of the melting temperature is assigned to the action of alkalies.

The alkalies also considerably reduce the viscosity of the residual mass. This fact is evidenced by the observation that in conducting a burning test on this mixture, after half an hour's heating to a temperature of 1400 degrees C., there are still fissures to be seen in portions of the outermost surface of the product after it has been slowly cooled. It also appears that there is difficulty in securing a uniform mixture of the cement in the kiln, although the constant rotation of the kiln is very potent in bringing about uniform mixing.

These experiments then show what role is played by the residual melt in the hardening of the cement. The "raw cement mixture without the presence of bicalcium silicate" is melted and ground. The color of the powder obtained in this fashion was the same as that of cement, only a shade darker.

Setting experiments were then carried out with this product. The samples made with this cement absorb water very rapidly but their consistency is only very slight. They also contract to a certain degree which may be considered to be due to the high proportion of lime that they contain.

The lime content of the residual mass in clinker form is considerably less due to the fact that it is removed by the bicalcium silicate. For this reason an additional mixture was examined which contained two and one-half molecules of lime less than the raw cement mixture on the basis of one molecule of silica. The composition of this mixture must therefore correspond to that of the residual melt after the burning process. The molten mass obtained from this mixture in the ground form reacts less vigorously with water and harden very satisfactorily in air. On the other hand when tested under water the product completely disintegrates to form a paste within a period of a few weeks.

The conclusion must be drawn from these experiments that the presence of the residual melt in the cement has only a very slight effect on the character of the hardening process. It might be possible that its influence is catalytic.

It is first possible to determine what compounds are the component parts of the residual melt, when the ternary system, lime-silica-iron oxide, is established. Then it becomes possible to determine just which are the compounds that are designated as "belite," "celite," and "felite" by Toernebohm.

A very accurate picture is obtained of the constitution of a portland cement clinker from a study of all the observations that have been described in this article. This information has not been available up to the present time in the technical and trade literature. The results will be summed up in brief detail in the following.

In the process of heating raw cement mixtures of the most varied composition (which composition is nevertheless within the realm that corresponds to that of the portland cement manufactured today), the same conditions and proportions are always produced within the temperature range that exists in the manufacturing process. The silica present in the cement forms a compound with two molecules of lime at a temperature between 1100 and 1200 degrees C. The residual mass consists of lime, alumina and iron oxide for the most part and it melts at a temperature of approximately 1285 degrees C. This residual melt surrounds the crystals of bicalcium silicate. When the mass is further heated, then the bicalcium silicate absorbs the lime from the residual melt and forms a solid solution with it. The quantity of the lime present in the bicalcium silicate amounts to approximately 10 per cent of the total mass of the latter. This absorption is a very important factor and indeed the most determinative factor as far as the quality of the burnt cement is concerned. A further institution of equilibrium does not take place within the temperature range that exists in practical operations. Due to local overheating it may be found in rare instances at temperatures which are higher than those that prevail in practice.

The beta bicalcium silicate, which contains a high percentage of lime, is the constituent of the clinker which exerts the hydraulic hardening influence and which has been designated with the name "Alite" in common nomenclature. The proportion of this ingredient can vary to approximately 60 per cent of the total volume of the clinker.

The role that is played by the residual melt is twofold. It determines in the first place the absorption of the lime excess contained in it by the bicalcium silicate and furthermore the residual mass fixes the latter on hardening in the hydraulically active indispensable modification. The residual mass is therefore an indispensable preliminary condition for the manufacture of a hydraulic binding agent, in spite of the fact that it really plays no important role either in the setting or the hardening of cement. This fixation effect is very favorably influenced by the quick cooling of the burnt cement.

The roles that are played by the iron content and the alkali content of the cement are also of twofold nature. In the first place the addition of iron and alkali reduces the melting point of the residual mass by approximately 110 degrees C., and in the second place it decreases the viscosity of the melt to such an extent that it surrounds the solid phase quickly and completely. It is, therefore, easy to produce a cement which does not contain alumina, while it is very difficult on the other hand to obtain a cement within the temperature range attainable in practical operations, which cement will contain only lime, silica and alumina.

Neither tricalcium silicate nor the compound, $8CaO.2SiO_2.Al_2O_3$, can be formed in the burning process as carried out in common practice today. Mixed crystals or tricalcium silicate and calcium aluminate are not formed. Hence all the hypotheses, which have been advanced for the explanation of the constitution of the portland cement clinker and which presuppose the existence of either one of these three possibilities, are faulty.

It is found that the more lime the raw cement mixture contains, the more lime will be found in the residual melt and hence the easier and the more will lime be absorbed by the bicalcium silicate. If, however, the saturation point of the latter substance for lime is overstepped, then free lime remains and causes various bad effects after the setting of the cement.

Editor, Manufacturers Record Urges More Raw Material Development In South

Rapid advances in the Southern cement industry, interest in the development of which was initiated and fostered by the American Mining Congress, was referred to by Richard H. Edmonds, editor of the Manufacturers Record of Baltimore, Maryland, in a message read on March 21st, before the Industrial Development Conference of the Southern Division of the American Mining Congress.

Mr. Edmonds stated that before the American Mining Congress conducted an industrial survey of the South a few years ago, it had been claimed that Florida could not produce portland cement. He stated that its survey showed that there are great resources in Florida. "As a result of that specific work, one plant costing $5,000,000 is nearing completion near Tampa, and another plant to cost $3,000,000 is to be built by cement makers of Pennsylvania," said Mr. Edmonds.

Mr. Edmonds declared that the American Mining Congress is "heading a movement which can be made of limitless value to the mineral and industrial interests of the South and of the country," as the utilization of raw material from Maryland to Texas is of great importance. He stated that the entire output of sulphur in the United States comes from the South and constitutes a large proportion of the world's production. "Development of Southern mineral resources will add enormously to the wealth and power of the country," said Mr. Edmonds. "In Texas, potash has been discovered, giving promise of equaling if not surpassing the potash of Germany."

Mr. Edmonds stated that a monument to the late President Harding will be built of Georgia marble costing $500,000. Ten million bricks have been shipped from Virginia for building construction in New York, and South Carolina brick is in demand for architects, having been used in construction in St. Paul, Minnesota and Atlantic City. Contrasting the present use of Southern mineral resources with the lack of care in former times, Mr. Edmonds stated that years ago a railroad in Georgia used marble for ballast while one in Alabama used high grade iron ore for the same purpose on the theory that it was the cheapest material. He quoted an Italian sculptor as saying that marble in the Shelby district of Alabama ranked with the finest Italian sculpture marble. This district is now producing fine marble for use in the interior of many costly buildings throughout the country. Granites of Texas are being used for large structures and monuments in many places. Mr. Edmonds said it is claimed that the clays of Georgia are of sufficient quantity to supply the country for centuries to come, and that the almost limitless quantities of lignite in Texas and Louisiana will furnish fuel in abundance and at low cost to industries of those States. Some Texas railroads are preparing to use powdered lignite as locomotive fuel and a power plant in Texas is operated with lignite. Mr. Edmonds stated that Tiffany and Company had pronounced some of the diamonds produced in Arkansas as equal to the best ever found anywhere.

"Call the roll of all the minerals on which the world's industry is founded and but few of them will be missing from the South," said Mr. Edmonds. "In olden days the South led the country in mining gold, and it is possible it may again do so under modern mining methods, as movements looking to the opening of some of these mines which proved proficient producers of gold before the Civil War are now under way. From Texas we get quicksilver and from Arkansas and other Southern States bauxite, which is the foundation of the aluminum business. So extensive are the South's mineral resources, so varied and so well located geographically for development, that scarcely any limit can be set to their development."

Mr. Edmonds stated that to fully utilize Southern natural resources, it is essential that there be imposed a protective tariff high enough to safeguard the country against cheap labor of the Orient and Europe. He stated that Virginia furnaces are not operating because they cannot produce iron under present conditions at a profit, as pig iron made in India can be delivered at Lynchburg for $2 per ton less than the cost of production in Virginia. He said a protective tariff is necessary "to safeguard American prosperity and American wages."

Gypsum Rock Used for Hotel Flooring

Floor construction of a comparatively new type is being employed in the Argonne hotel, which is being built in Twelfth and Thirteenth streets, between Madison avenue and Adams street, for H. J. Arenson. This floor material is gypsum rock so manufactured that when mixed with water and an aggregate it can be poured just as concrete is poured. The gypsum is fireproof and will make fire barriers out of the floors of the hotel.

RICHARD KENNEDY LOOKS AFTER DETAILS IN SAND AND GRAVEL OPERATION

By F. A. Westbrook

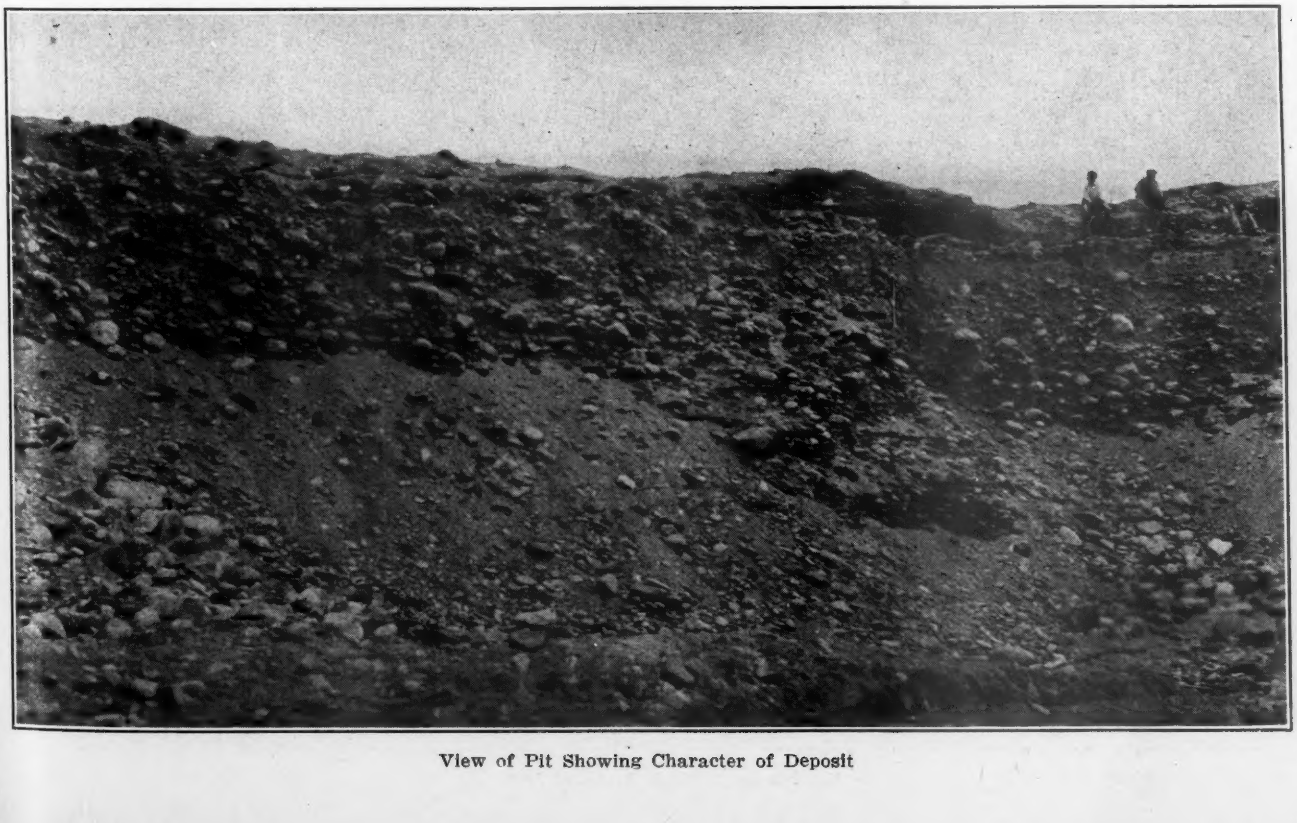
RICHARD Kennedy and Company, Incorporated, of Portland, Maine, operate an interesting sand and gravel operation. This is located at North Deering, about five miles from Portland, and consists of a deposit which has the advantage of a reasonably stony bank. The fact that electrical power is not available at this location in sufficient quantity to run the plant has led to some rather interesting practices which will be described.

Excavating is done by an Erie Steam shovel of the Crawler tractor type, equipped with a 3/4 yard bucket. This places the material in a 3 yard Packard truck equipped with a Wood hoist which delivers it to the grizzly. Instead of turning around after each load the truck runs forward from the grizzly to the steam shovel and then backs down grade to the plant with the load. The machinery at the plant is New England Road Machinery Company equipment and consists of a jaw crusher, elevator and screen.

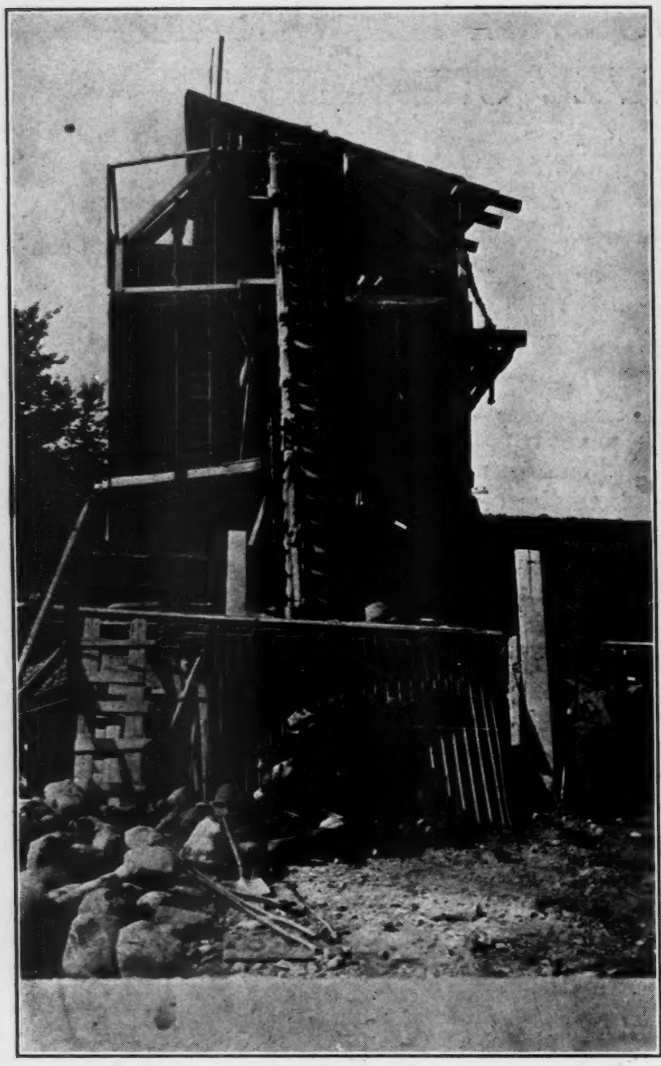
The material which passes through the grizzly drops into a hopper and the cobbles drop into the crusher. This also discharges into the same hopper and from here the material is elevated to the screen. The flow of material from the hopper into the elevator is controlled by hand, as shown in one of the illustrations. In the absence of electrical power, the crusher is driven by a Fordson tractor, and the screen and elevator are operated by a Wisconsin tractor engine. The crusher is not run continuously, but depends on the amount of stone coming from the pit.

The screen separates sizes as follows: sand, 1/4 inch to 5/8 inch, 5/8 inch to 1 1/2 inch, 1 1/2 inch to 2 1/2 inch and tailings. The tailings are dropped on the ground from the end of the screen and are used when clear crushed stone is desired, being taken back to the crusher by the Packard truck. This work is frequently done on rainy days when the plant otherwise would be shut down. As the plant operation is only to supply requirements of this company's contracting business and as little contract work is carried on during the winter the plant is not in operation during this period.

Probably the most interesting thing about this whole operation is the way small details are attended to and made important. Mr. A. E. Clough, the foreman, is very ingenious as well as conscientious in this respect. For instance, very good use is made of a Barber-Greene 45 foot loader, operated by a gasoline engine. It sometimes happens that the Erie steam shovel is taken away to do an excavating job, say on the cellar of a building or other construction job. At other times the shovel is being used for stripping above the pit, when there is a demand for material. Under these circumstances, the Barber-Greene loader is used at



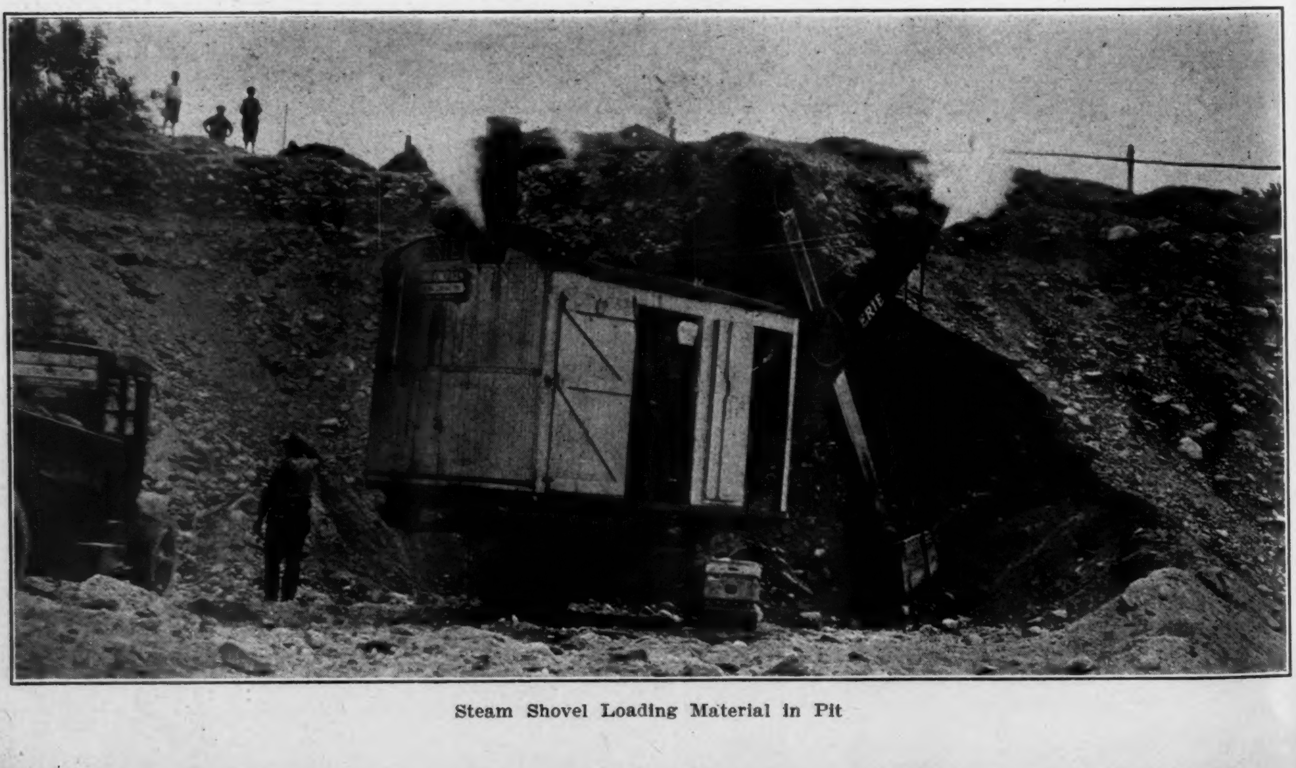
View of Pit Showing Character of Deposit



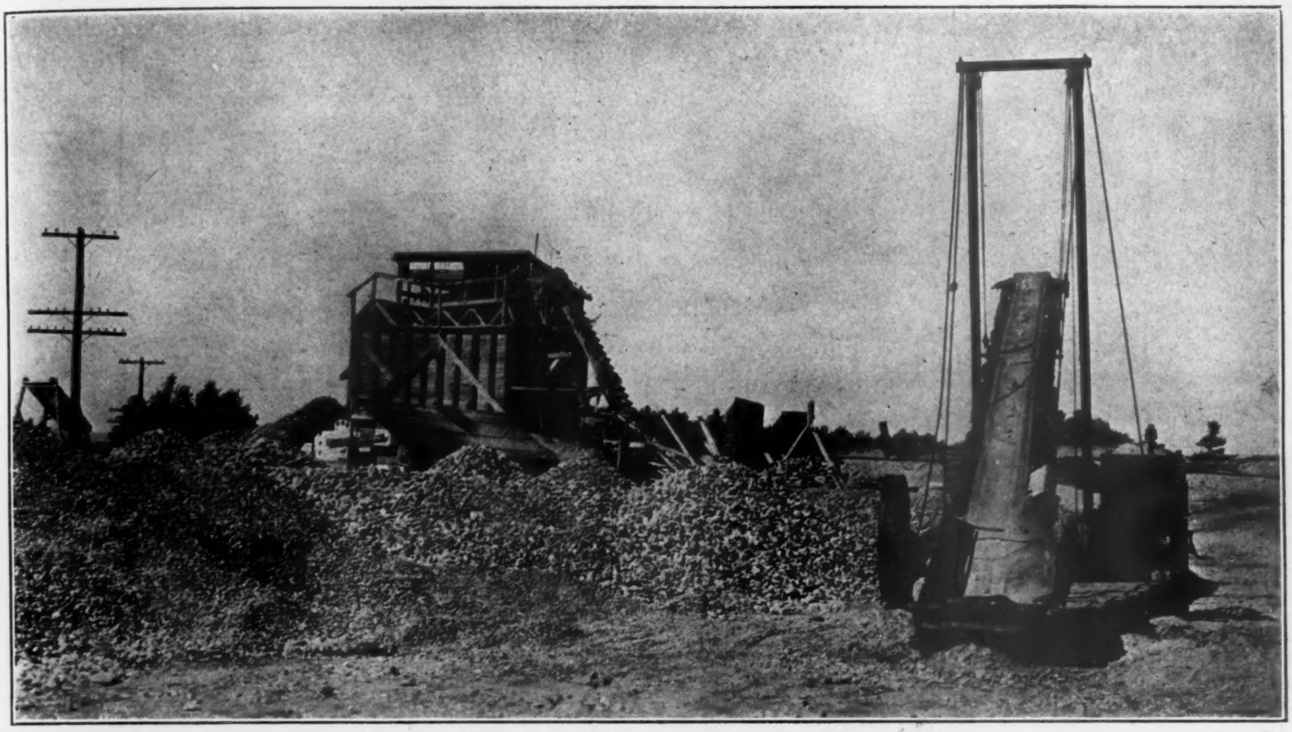
View of Grizzly and Elevator

Manual Feeder Control of Material from Hopper to Elevator

the gravel bank. Sand and gravel is shoveled on to it by hand and the truck loaded, which serves the plant. Five or six men can load the 3 yard truck in this way in seven minutes. The plant has several storage surplus piles of various sizes, but these piles are kept as small as possible and the



Steam Shovel Loading Material in Pit



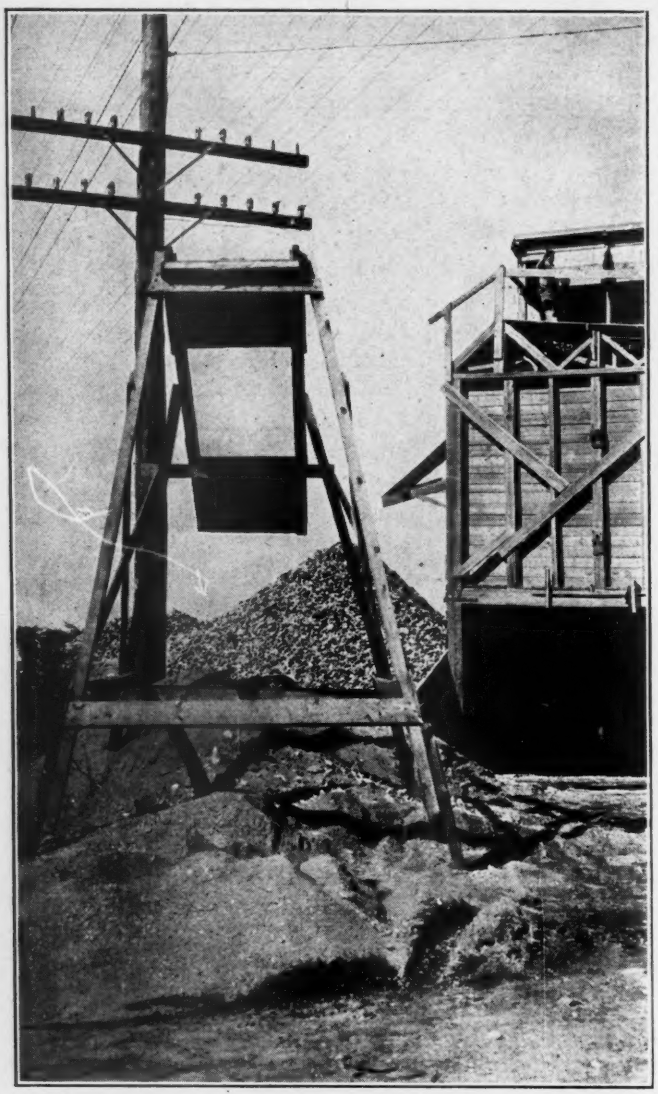
Loader, Surplus Piles and Screening Plant in Background

loader is used for filling trucks from these piles.

Occasionally some of the gravel or crushed stone from these piles needs rescreening. To accomplish this without interfering with the operation of the plant an inclined stationary screen has been rigged upon a tall framework. This can easily be moved when necessary and fitted with different sizes of wire mesh as desired. When a load of rescreened material is needed, the portable screen is moved to a point near the appropriate pile. The loader is then used to carry and drop the gravel or crushed stone on the screen. As the dirt passes through the mesh the clean materials slips down the incline on to a truck backed under the low end. This arrangement is a very simple and ingenious way of saving labor.

This loader is also used to load freight cars directly from a truck. For instance, a year or so ago the company had an emergency order for 2,500 yards of crushed stone. Quick shipments were

Motor Truck Loading at Storage Bins

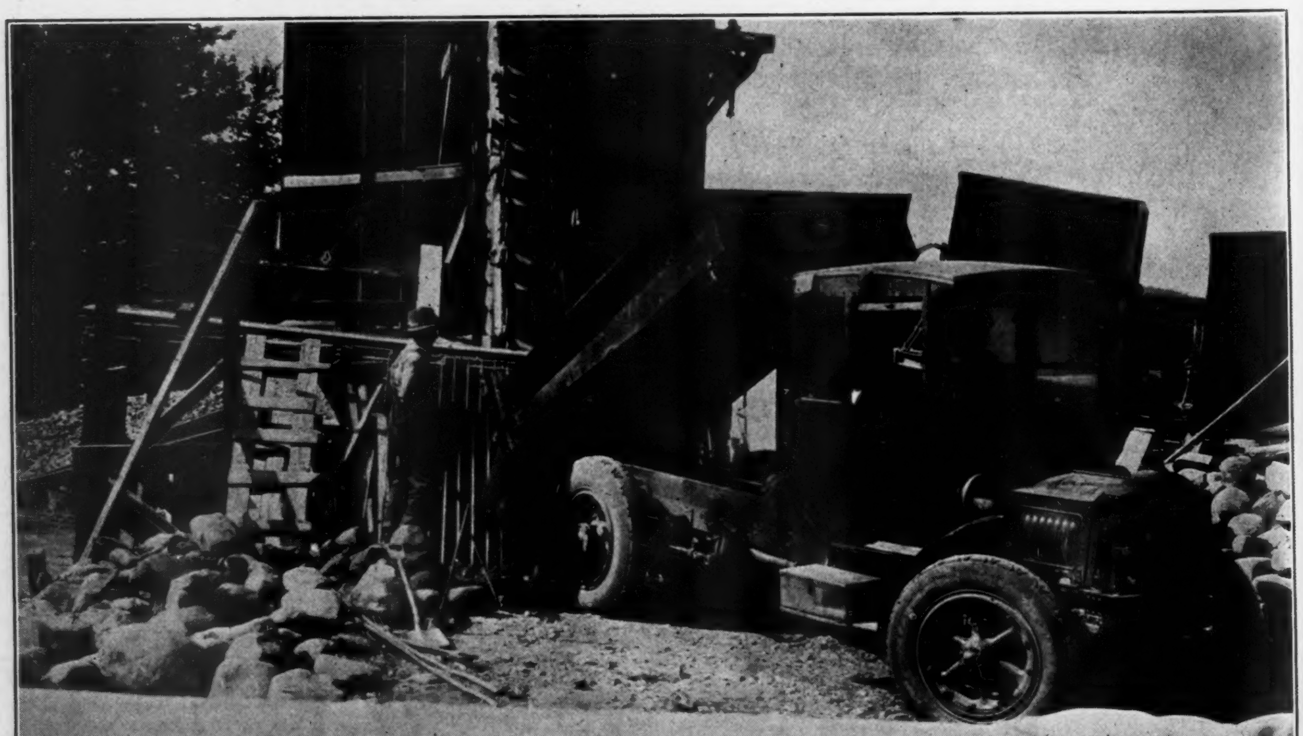


Portable improvised Screen for cleaning Material taken from Piles of Surplus

very necessary and to meet this demand the loader was taken to the nearest railroad station, about 2½ miles away, and left there. When a truck load of material arrived, one end of the loader was placed over the car and the motor trucks dumped the material directly on to its lower end, through an opening in the tail board. The belt conveyor then loaded the crushed stone directly into the freight car without rehandling.

Mr. Clough also has things organized so that each man has his own particular duty to perform, preparatory to starting in the morning. In this way, a large number of important details are attended to with regularity which would otherwise be neglected. Thus all grease cups are filled every other day, on alternate days the cups are turned down. Another man fills the gasoline tanks of the engines, and it is a strict rule that this shall never be done when the engines are in operation. Still another man shovels out the pit under the lower end of the elevator, a thing Mr. Clough never permits when the machinery is in operation. The steam shovel is blown out once a month so as to avoid accumulation of scale and as a result of the general good care which it has received, it looks like new, although it has seen much hard service. Other similar details are attended to but only enough of these have been mentioned to give an idea of how things are managed. With everything systematized in this way, there is little lost time in getting started in the morning, and nothing is neglected which may afterwards interfere with production.

An indication of the care exercised by the foreman is the playing of a stream of water from a



Truck Dumping Load at Grizzly

hose every night, after closing, around the floor and base of the Wisconsin engine. This is located in a wooden lean-to building against the wood storage bins and the engine also rests on timbers. Sparks sometimes come out of the exhaust and to make sure that no smouldering fire is started from these sparks everything near the engine is thoroughly saturated with water. It takes only two or three minutes to do this and is an excellent "ounce of prevention."

Probably this thoughtful and painstaking care results in large measure from the inspiration of Mr. Kennedy. Without going into details of the management policy it is enough to say that some of the men working at this plant have been there for years in spite of the fact that they are laid off every winter. During this period they get longshoremen jobs but are glad to come back as soon as operations open up at the plant in the spring.

Before closing this account it should be said that deliveries of materials are made by four trucks,—two Packards and one Mack, equipped with Wood hoists and one hoist equipped Autocar. A full day's production is 300 tons and this is accomplished with five men, besides the foreman. The duties of these men are as follows: one on the screen; one on the grizzly platform; one feeding the elevator; one attending the truck and the last operating the shovel.

Highways In Rumania

Rumania has an extensive system of roads totaling in length some 53,000 kilometers and classifiable as follows:

1. National roads, constituting the main highways of the country, which are maintained by the State, which do not exceed 9,000 kilometers. These are the most satisfactorily kept roads, constructed generally of crushed stone or packed gravel and with a width of some 25 feet.

2. District or departmental roads, the upkeep of which is a charge on the 71 Rumanian districts through whose territories the respective roads pass. These district roads, comprising some 12,000 kilometers, are in a poorer condition than the national roads, although constructed generally of macadam.

3. Communal roads, of some 32,000 kilometers, generally of a very inferior quality, consisting for the most part of plain dirt roads. The cost of their upkeep is met by the villages which the respective roads traverse.

Construction of new roads in Rumania, maintenance of their existing roads, and purchases of equipment and materials, are under the supervision of the Technical Service of the Ministry of Public Works, Division of Roads and Bridges. This service provides a technical staff and equipment for the repair of district and communal roads, the material and workmen therefor being provided by the respective districts and communes.

On account of a lack of resources, the Ministry of Public Works is poorly provided with modern road making and maintenance equipment. In 1926, for example, the budgetary allocation for the Division of Roads and Bridges of the Ministry of Public Works was only 75,000,000 lei (approximately $375,000), the greater part of which sum was expended for salaries and for road material, leaving only a relatively small sum for the purchase of equipment.

Twenty Largest Cities

The Newspaper Features Bureau of Wheeling, W. Va., has estimated the population of the twenty largest cities as follows:

1.	New York City	6,323,000
2.	Chicago	3,152,000
3.	Philadelphia	2,052,000
4.	Detroit	1,431,000
5.	Los Angeles	1,269,000
6.	Cleveland	996,000
7.	Boston	860,000
8.	St. Louis	835,000
9.	Baltimore	826,000
10.	San Francisco	709,000
11.	Pittsburgh	686,000
12.	Buffalo	591,000
13.	Washington	536,000
14.	Milwaukee	526,000
15.	Newark	473,000
16.	Minneapolis	449,000
17.	Kansas City	438,000
18.	New Orleans	430,000
19.	Cincinnati	429,000
20.	Seattle	404,000

Refractory Products

In the manufacture of refractory, acid-proof and other ceramically bonded articles from non-plastic materials such as grog, fused alumina, corundum, sillimanite, carbides, zirconium compounds, chromium oxide, magnesia, silica, etc., these materials are mixed with an alkaline kaolin slip in such proportions that a non-castable mass results. This is molded by beating, stamping or pressing into articles which are then dried or burnt, or in some cases used without burning for furnace linings, etc. A portion of the non-plastic material may be added during the preparation of the kaolin slip. When the slip is to be used in small proportions it may be diluted for admixture with the other materials, the excess of water being subsequently removed before moulding. Instead of kaolin, a colloidal slip prepared by adding an electrolyte to pure alumina or aluminum hydroxide may be used. Scheidhauer & Giessing Akt. Ges. (British Patent 263,194).

MINNESOTA HIGHWAY DEPARTMENT KNOWS VALUE OF WELL ORGANIZED RESEARCH

By F. C. Lang

Engineer of Tests and Inspection, Minnesota Highway Department

THE Minnesota Highway Department appreciates the value of well organized research. We believe that for problems other than those purely local, research is best carried on in cooperation with the government, other States, or technical societies. It may take somewhat longer to get results but the conclusions when finally drawn are less subject to error and personal opinion.

At the present time our laboratory is carrying on the following investigations in cooperation with other agencies:

1. Effect of tensile strength of cement on the strength of concrete.

2. Standardization of field transverse concrete beam testing machine and method for use.

3. A new method of testing sands using water cement ratio.

4. Use of calcium chloride integrally as an admixture and curing agent.

5. Study of fluid cement water mixtures as a criterion of the concrete making value of portland cement.

Independently of other agencies we are conducting the following investigations:

1. Effect of shape and character of aggregate on resulting strength of concrete.—Compressive and transverse tests are being made, using, under identically the same conditions, a smooth, uncrushed, impervious, igneous gravel as coarse aggregate, a crushed limestone, a crushed trap, a commercial gravel containing cracked oversize, and a porous sandstone. The specimens are all broken at 3, 7, and 28 days. Results will be available about April 1, 1927. In these tests the absorption of aggregate is being allowed for in computing water cement ratio.

2. Frost protection necessary for concrete.—This investigation was started at our Duluth laboratory last year and is being continued at the same place. Concrete beams are exposed to freezing at different ages and some are repeatedly frozen and thawed. Beams are also cured indoors at two temperatures above freezing point, approximately 40° F. and 70° F.

3. Durability of paints.—Approximately two hundred panels have been placed in this exposure test beginning in the spring of 1926. Some results are now conclusive.

4. Bituminous treatment of gravel roads and earth grades before graveling.—This we consider the most important and far-reaching investigation that we are carrying on. In this State we have a trunk highway system of approximately 7,000 miles, of which there are about 850 miles paved and over 5,200 miles of gravel. In some localities, gravel is scarce and expensive and its conservation is very important. Some of the gravel roads should and will probably soon be paved as they are carrying very heavy traffic. There still remains a large mileage where the traffic is not heavy enough to justify paving and yet the gravel surfacing is unsatisfactory, both on account of the cost of the gravel and the dust nuisance to motorists and residents along the highway, as well as the inability to maintain a smooth riding surface at all times. The gravel as used in this State contains from 40 to 75 per cent passing a No. 10 sieve, so in many instances there is not much actual metal in the surface. In addition, there is a considerable variation in the quality. It is placed on all kinds of sub-grades from heavy clay to granular soils. We are attempting to determine the best materials to use for various conditions of gravel and subgrade. In 1926 we constructed 81 miles of tar on gravel, 66.5 miles of oil on gravel, and 615 miles of oil on earth subgrade just previous to gravelling. Several different kinds of road oil were used. Careful records of application procedure and maintenance costs are being kept. Bituminous materials and soils are analyzed. This investigation will be continued, with special observation during the spring break-up on heavy soils. The investigation was started in 1924.

5. Vibrolithic pavement.—In October, 1921, about 2,200 feet of Vibrolithic pavement was constructed, using different proportions and different kinds of aggregate. In this 2,200 feet ten different sections were laid. The effect of lean mixtures is now apparent. There has been no maintenance up to the present time except filling cracks.

6. Concrete pavements.—Concrete pavements have been under observation for several years. As a result of study and observation we are now constructing contraction joints every 40 ft. 4 in., making the opening clear through the slab and filling the surface where a cap has been removed with bituminous material. Pavements similarly constructed about three years ago with longitudinal joints are practically free from cracks.

LEADERSHIP IN THE QUARRY INDUSTRY

By R. N. Van Winkle

IN a recent issue of Pit and Quarry the writer was so bold as to have an article entitled "More Engineer Crushed Stone Executives Needed for 1927." The idea in writing such an article was to bring to the attention of the readers of this publication the possibilities of the use of engineers in quarry and open pit mining operations and specifically engineers as executives. It was not the intent of the article nor was it the writer's desire in any way to champion the cause of the engineer, but it was my idea to bring to the attention of the owner and operator the possibilities of engineers and engineering training as might be applied to this industry. It may be of more than passing interest to know that the question of engineers as executives is receiving very serious consideration and much comment right now by American industrial enterprises as a whole, with the score in favor of the engineer.

While the writer attempted to explain in his article above referred to what the qualifications of an engineer, who might be helpful to our particular industry, really were, he is afraid the qualifications were not made clear. Since the publication of this article, "More Engineer Crushed Stone Executives Needed for 1927," the writer has been told his engineer as described was a myth and that an engineer as a quarry executive was impossible or far fetched.

With these and many similar remarks in mind the writer has attempted in his own small way to analyze these remarks in an endeavor to learn, if possible, why our industry appears to be rather outstanding or reluctant in accepting engineers, engineering principles and the idea of engineering executives, all of which are accepted and successful in a great many other American manufactories and industrial enterprises.

There is a feeling, the writer believes, among the men engaged in our particular industry, still this may not be true, against the mere word engineer as applying to their industry. Some people have the idea that because a man is an engineer it practically disqualifies him, due to his training in figures, technical data and scientific training, to play any part in, or fit in, a more or less rough and tumble quarry or open pit operation, where it is thought a man must be a man of strength and endurance, instead of education.

The very first qualification of an engineer to be successful as an engineer for any kind of a job, executive or otherwise, is that he be a man and work at being a man. If he is not first and foremost a man in every respect, leave him alone. It might illustrate the point the writer is attempting to put over to quarrymen in reference to engineers as quarry executives to state what other people think of engineering executives and the qualifications they think are necessary.

Mr. E. M. Herr, President, Westinghouse Electric Company, in a recent address said: "That executives in important positions should have engineering training has long been recognized in many American industries, as well as in some railroads, which have made it a point to select their chief executives only from men with such training.

"What are the requirements engineers must have to qualify for these high executive positions? They must be men with ability to lead and direct others; they must be men of decision and initiative, trained in evaluating men and materials; they must be men of vision and of courage—not reckless, but with full appreciation of their responsibility for the results of their acts and decisions; and perhaps, most of all, they must be men able to make proper decisions as to economic conditions and prospects. Executive ability is the ability to guide and direct others. It is inborn, and not acquired. Where it exists, it can be developed and strengthened by practice and training.

"It must be clearly kept in mind that no amount of study and no amount of training will enable a young man to become a high executive, or even to occupy an executive position of any kind unless he has the ability to direct others, and, by reason of his knowledge of the business, to take the lead in the work to be done. He may be a remarkable designer, an inventor of high attainments, a skilled technician, or he may have wonderful qualifications in many directions, but unless he can lead and direct men, he cannot qualify as an executive. Nor can every leader of men qualify as a high executive, or be placed in charge of a great industry. Here, the knowledge of business conditions, the quality of leadership secured only after years of business training, the business judgment, the courage, persistency, and will power to carry through, all of which can only be obtained in the hard school of actual experience, are vitally needed in the attainment of a high executive position. Manifestly, these cannot be learned in any school or college, but must be inborn in the man himself, awaiting development by environment and opportunity in the business undertaken.

"Given all these things, there is yet another quality demanded of one who would direct a great industry—the ability to forget one's own personal wishes and plans and be willing to make any sacrifice, to place one's whole self except one's honor upon the altar of business achievement."

To sum up briefly what has been quoted above, Mr. Herr believes that engineer executives cannot be produced by college training and education, which while very true, should dispel in the reader's mind that a certificate of graduation or diploma makes an engineer, which too often is the impression gained. Mr. Herr believes leaders or executives are born, not made, as a man must have the real quality of leadership and if he has this quality, it can be stimulated and developed by proper education and training, but this training must be largely in the business itself.

Mr. H. A. Guess, Vice-President, American Smelting & Refining Company, in a recent article compares the engineer with other professional men: "After all engineers are not very numerous as compared with these other occupations and, therefore, a lesser number reaching high executive positions, stated numerically, might be a larger number, stated as a percentage.

"Pursuing this matter of comparisons and considering now, doctors: Every one knows there must be throughout the United States, say, three doctors to one engineer; but even numerically probably there are not as many doctors in high executive positions as engineers; and it is a fortunate thing for the country that doctors as a class are so busily engaged in alleviating sickness and suffering and in the advancement of medical science, that they do not aim particularly for high executive positions.

"Consider next the legal profession. Without looking up a census of all the lawyers in the United States, doubtless there are at least two lawyers to one engineer. Further, it must not be forgotten that the ever-increasing complexity, during the past twenty years, of laws with respect to personal and corporate behavior, and the penalties for inadvertent or other misbehavior either of omission or commission have been a veritable manna from Heaven to the lawyers, to whom, with growing frequency, every individual and corporation must turn for legal guidance.

"Under these circumstances it seems little short of a miracle, that today there are any high executive positions not occupied by lawyers. However, as a matter of fact, while a number of the large corporations have as their head or sub-head a seasoned lawyer of wide business experience, it is doubtful if there are in high executive positions today, as many lawyers as engineers, stated as percentages of the total number of each profession. The two remaining classes of the occupations previously mentioned for comparison, are bankers and so-called business men, which would include manufacturers, merchants, etc. Lumping these together as one gives a class much more numerous than the combined doctors, lawyers and engineers.

"It is natural, therefore, that from this class should come those holding the majority of the high executive positions, because even though not engineers, they are very clear headed, are in many cases college graduates, and have been trained in the greatest of all universities, namely, the modern business world. On the whole, therefore, the Engineering Profession is securing about its percentage share of the high executive positions in America, with the possible exception of the banker class."

The extracts from the addresses given above are to show, if possible, that men like Mr. Herr and Mr. Guess, who are responsible executives, are not opposed to engineers and more important yet do not feel that obtaining a degree or diploma makes one an engineer, as some seem to think. Integrity, sustained energy, skilled knowledge, tact, personality and, most important of all, basic common sense, are in these gentlemen's judgment the qualities that should be characterized in engineering executives. Certainly not many of these can be taught as subjects in a college course, but they can be stimulated and fostered in business.

What appears peculiar to the writer is that more engineering talent has not been already employed as a matter of good business in our industry. The trained and seasoned engineer is as important and can render you just as much service as your doctor or lawyer. Present day civil sense or common sense engineering, let's call it, is a relatively new factor in modern times, but it is, believe me or not, the most important single factor in modern business which involves any engineering. Unquestionably quarrying and open pit mining are primarily based, opened up and developed on engineering principles and data; so why should we side-step engineers and engineering executives in the carrying on of our every day business? Why should we, on the contrary, not seek out young engineers, develop them and promote them even to executive positions, provided we can find young engineers who possess the necessary qualifications to act successfully. For one, the writer is sure it would develop the industry, which is now cramped, and eventually give us new ideas, new thought and new leaders. Doubtless we will make some mistakes at first in selecting these young engineers, they too will make mistakes, but unquestionably out of it all we will develop a class of men who will not alone be capable engineers, but leaders and experienced quarry executives.

To use a borrowed expression, too many of us in the industry, and by us the writer includes himself, are taking what comes out of the rut of life and are not using our faculties to the best advantage to better our conditions and attract bright young men and engineers to our industry. We could all use these young men whether engineers or not and by a little trouble on our part broaden their experience by moving them from one type of work to another, as long as they show the necessary qualifications, and in this way develop in a few years a reserve of experienced men and talent that would never come amiss in our business or any other for that matter.

If you are an executive or superintendent and are democratic and of a kindly disposition, try this experiment of developing young men. Pass around a little cheer and encouragement among the men you come in contact with, who may not be as fortunate as you are; this, together with the developing of men, has been the outstanding characteristic of every great leader in the world's history, of soldiers, rulers, teachers, preachers, and captains of finance and industry. Besides that it will be a source of great interest, satisfaction and comfort to you in many ways. The more experience the writer has in the business world the more he respects organization, and one way to build up an organization is to take promising young men and develop them. It is well for the executive to remember that in any business enterprise one cannot continue to take everything out and put nothing back, and this applies especially to the human relation proposition. You must constantly build for the future and have a regard and knowledge of men's feelings, reactions and impulses and remember, too, that your success is directly dependent upon your subordinates and the organization you build.

This brings the writer to one of his favorite topics—the accepting and using as 100 percent pure the free information and engineering service rendered by machinery manufacturers. We in the industry have, as a general thing, built up no engineering staff ourselves and immediately turn to the manufacturers of machinery for engineering information and advice. True enough this service is free, and why—it's free because the man who comes out to see you comes not in an advisory capacity, for his company could not keep him on the road to dispense free engineering information, but he comes primarily as a salesman to sell you something; sales are primary, engineering information secondary. This man cannot as a rule give you unbiased advice, especially if the advice would lose him a sale, or admit that some other manufacturer made an article better suited to your condition than his. This man is paid a salary in proportion to his sales, not in proportion to the engineering information and data he gives away. Still with this in mind we accept their advice, buy their machinery quite often to our sorrow and refuse to build our own engineering organization, or go outside and hire an unbiased consulting engineer who would look at our problems through our eyes rather than through the eyes of a salesman. This practice, the writer can almost call it, of accepting as 100 percent pure, the free information and engineering service by machinery manufacturers and their representatives, quite often results in our following rather blindly into conditions where we should never have been led, due to the accepting of this free and quite often erroneous information.

It is only through constant harping on the subjects we have in mind and driving in a wedge at every opportunity that we quite often gain our point and lift our proposition up to where it is really observed and recognized. It is with some satisfaction that the writer can look back on one of the first articles he ever wrote for publication, which was entitled "Quarry Engineering," and that was in 1923, some four years ago. Since that time the writer's view has not changed on the subject and as way for proof he begs leave to quote extracts at random from that article:

"It's being modest when I say that 75 percent of the quarries in this country today are sadly in need of seasoned technical engineering brains and advice. By this is not meant the brains of so-called sales engineers, but brains of unbiased engineers who have not only technical training but the actual experience in quarry operation and management. Lack of attention and forethought to field operation:—that is to say, operations outside of the mill and crusher plant—have brought more real grief to the average quarryman than any other one thing. It will pay the quarryman handsomely if he will occasionally seek the advice of a technically-trained, unbiased, experienced engineer."

Ever since writing this article, "Quarry Engineering," which gave me the first opportunity to express my thoughts, the writer has pioneered, you might call it, the question or cause, and has missed no opportunity to drive a wedge or harp on the question of engineering in relation to the quarry and open pit mining industry, not as a champion of the engineer but as a help to our industry. The idea has in a measure found some fertile spots and taken root, as I have recently met several mining engineers engaged in producing stone and shale for cement plants, one quarry company that has recently availed themselves of the services of a mining engineer for their own organization, one or two State Stone Organizations have engineers as secretaries, while our National Association in the stone industry has an engineer of repute in charge of research and tests.

Hydraulic Bituminous Cement

Molten cement mixed in a mechanically agitated apparatus is mixed with so much cement and additive materials like gravel, sand, stone, fibrous materials, etc., that it clumps together even at a high temperature. The product is cooled, and ground with a further quantity of cement and with asphalt. The resulting material sets like bitumen-free cement, and the asphalt is not apparently affected by fluctuations in the temperature. — della Coletta (Austrian Patent 104,733).

AMERICAN SOCIETY TESTING MATERIALS HOLDS SPRING GROUP MEETINGS

THE spring group meeting of the committees of the American Society for Testing Materials was held in Philadelphia at the Bellevue Stratford Hotel on Tuesday, Wednesday, Thursday and Friday, March 15 to 18th. This group plan of holding committee meetings, which was adopted some few years ago, has proved quite successful. Twenty-five committees took part in the meeting this year as follows:

A-1 on Steel
A-3 on Cast Iron
A-5 on Corrosion of Iron and Steel
A-6 on Magnetic Properties
A-8 on Magnetic Analysis
B-1 on Copper Wire
B-2 on Non-Ferrous Metals and Alloys
B-3 on Corrosion of Non-Ferrous Metals and Alloys
C-3 on Brick
C-7 on Lime
C-9 on Concrete and Concrete Aggregates
C-11 on Gypsum
D-4 on Road and Paving Materials
D-5 on Coal and Coke
D-8 on Waterproofing Materials
D-9 on Electrical Insulating Materials
D-11 on Rubber Products
D-14 on Screen Wire Cloth
D-15 on Thermometers
D-16 on Slate
D-18 on Natural Building Stone
E-4 on Metallography

Meetings were also held of the Joint Research Committees of the American Society for Testing Materials and American Society of Mechanical Engineers on the Effect of Temperature on the Properties of Metals; of the Sectional Committee on Numbering of Steels and two Research Committees on Gray Iron of the American Foundrymen's Association. The meetings were attended by about 250 members and guests representing the industries concerned.

A committee consisting of J. H. Higgins, chairman, A. L. Ferguson, W. P. Smith, S. T. Wagner and J. K. Rittenhouse made the arrangements. The meetings were noteworthy for the smoothness with which they were run off and the efficient manner in which the work was taken up.

Lime

Committee C-7 on Lime held a meeting on Friday, March 18, to take action upon its various standards and the recommendations which the committee plans to present at the approaching annual meeting concerning them. Four of its tentative specifications covering quicklime and hydrated lime for use in the chemical industry, such as the manufacture of sulfite pulp, the manufacture of varnish, and for use in water treatment, are being recommended for advancement to standard. Other of its tentative specifications are being revised in regard to the chemical requirements specified.

H. C. Berry, Professor of Materials of Construction, University of Pennsylvania is chairman and J. S. Elwell, National Lime Association is secretary of this committee.

Concrete and Concrete Aggregates

Committee C-9 on Concrete and Concrete Aggregates at its meeting held on March 17 received a number of interesting reports from its sub-committees. The Sub-Committee on Design of Concrete has made a thorough review of the principle theories of design now advanced and has carried out studies directed toward the development of an adequate theory on which to base design method. Several years ago an extensive series of tests of concrete proportioning was carried out. The test data resulting from these tests are being studied at the University of Wisconsin in which study the Sub-Committee on Design is cooperating.

The Sub-Committee on Specifications has suggested a revision of that portion of the report of the Joint Commitee on Concrete and Reinforced Concrete relating to the preparation, materials and testing of concrete. This revision is believed to be advisable by the concrete industry as a whole, including both the large and small contractors engaged on either big or little jobs.

Committee C-9 thus far has been responsible for the preparation of eight standards and tentative standards dealing with specifications for concrete and concrete aggregates and methods of test. Clarity and definiteness are highly important characteristics of technical specifications and all of the specifications have been critically reviewed during the past year and certain editorial changes have been made which should greatly improve them and make them more acceptable.

The committee is sponsoring a comprehensive Symposium on Field Control of the Quality of Concrete, which will contain papers on the following:

Proportioning of Concrete
Mixing of Concrete
Conveying and Placing Concrete
Field Testing and Its Significance
Producing Quality Concrete in Cold Weather
Construction Joints and Expansion Joints
Transverse Tests as a Criterion of the Quality of Concrete

In addition the committee is securing papers on the design of concrete mixes and on the geological aspects of concrete aggregates, Cloyd M. Chapman, Consulting Engineer is chairman while Stanton Walker, Director, Engineering and Research Division, National Sand and Gravel Association is secretary of the Committee.

Road and Paving Materials

Committee D-4 on Road and Paving Materials held a well attended meeting on Friday, March 18, at which its work during the year was reviewed and final actions taken looking towards its report to the Society at the annual meeting in June. In the absence of the chairman, Mr. Adler, Past-President W. H. Fulweiler presided. The committee felt that a number of its tentative standards had proved during the course of several years to be satisfactory and warranted adoption as standard and will accordingly recommend that the following be advanced to that status:

- Tentative Method of Float Test for Bituminous Materials (D 139-25 T)
- Tentative Method of Test for Specific Gravity of Road Oils, Road Tars, Asphalt Cements and Soft Tar Pitches (D 70-26 T)
- Tentative Method of Test for Specific Gravity of Asphalts and Tar Pitches Sufficiently Solid to be Handled in Fragments (D 71-26 T)
- Tentative Method of Test for the Determination of Bitumen (D 4-26 T)
- Tentative Method of Test for the Determination of Proportion of Bitumen Soluble in Carbon Tetrachloride (D 165-26 T)
- Tentative Specifications for Broken Slag for Bituminous Macadam Base (D 195-24 T)
- Tentative Specifications for Broken Slag for Bituminous Concrete Base (D 196-24 T)
- Tentative Specifications for Broken Slag for Bituminous Macadam Wearing Course (D 159-24 T)
- Tentative Specifications for Broken Slag for Bituminous Concrete (Coarse-Graded Aggregate Type) (D 160-24 T)
- Tentative Specifications for Asphalt Cement, 30 to 40 Penetration, for Use in Sheet Asphalt and Asphaltic Concrete Pavements (D 164-23 T)

Certain revisions will be proposed in the Tentative Method of Test for Distillation of Bituminous Materials Suitable for Road Treatment (D 20-26 T). The committee desires to keep this method tentative and at the same time to have the Society withdraw the present Standard Method of Test for Distillation of Bituminous Materials Suitable for Road Treatment (D 20-18).

A number of revisions, mainly of a minor character, will be recommended in the various specifications that the committee has prepared covering tar products. In three of these, namely, Tentative Specifications for High-Carbon Tar for Surface Treatment, Hot Application (D 108-23 T), for High-Carbon Tar Cement (D 110-25 T) and for Coal-Tar Pitch for Stone Block Filler (D 112-23 T), certain changes will be proposed in test requirements.

The committee will recommend a slight modification in the present Standard Method of Test for Loss on Heating of Oil and Asphaltic Compounds (D 6-20) in order to specify in further detail the requirements for the thermometer specified therein to bring it into accord with recommendations of the Society's Committee D-15 on Thermometers. The committee will ask that these revisions be adopted at once as standard.

The committee considered a communication respecting the importance of the various interested committees of the Society reaching an agreement on standard sieves and screens for mechanical analysis of coarse aggregates, there being at present some discrepancy in the use of round-opening and square opening screens for essentially the same product. The committee will recommend that this matter be taken up directly with the Society's Committee E-1 on Methods of Testing.

Julius Adler, Consulting Engineer, is chairman while Prevost Hubbard, Chemical Engineer, The Asphalt Association is secretary of this committee.

Slate

The meeting of Committee D-16 on Slate, held on March 15, was well attended, particularly by representatives of the architectural profession, government officials and others. The committee considered tentative methods of test for electrical insulation of slate, which is expected to be presented at the next annual meeting. Consideration was given to suggested slight changes in the present tentative methods of testing slate for absorption and transverse strength as the result of experimental tests recently conducted at Lafayette College, Lehigh University and Rensselaer Polytechnic Institute. The tentative methods are expected to be advanced to standard.

Reports of various sub-committees were received and discussed, especially those on the weathering of slate. The tentative definition of slate was, with slight changes, incorporated in the report of the committee for this year as a standard definition of slate. It was proposed that a sub-committee be appointed to consider abrasive sand for rubbing beds for slate, because of the great economies that could be effected through increased slate production, through the grading and selecting of sand for this purpose. Preliminary studies may be made in the laboratories of the U. S. Bureau of Mines at New Brunswick, in the anticipation of receiving the cooperation of the producers. The laboratories of

Lafayette College have also been offered in cooperation.

The Fall meeting of the committee will be held in the Pennsylvania slate regions. D. W. Kessler, Associate Engineer, U. S. Bureau of Standards, is chairman of this committee while D. Knickerbacker Boyd, Structural Standardist of the Structural Service Bureau is secretary of this committee.

Natural Building Stones

Committee D-18 on Natural Building Stones, one of the more recently organized standing committees of the Society, held on Wednesday, March 16, what is considered to be a rather important meeting in further organizing the work of that committee in a way that will permit an actual start being made on the research and test program which the work of this committee will involve. In the absence of the chairman, Mr. F. Y. Joannes, in Europe, the meeting was presided over by the vice-chairman, Mr. W. M. Greig, Assistant Engineer, Delaware River Bridge Joint Commission, Philadelphia.

The membership was broadened by election of new members embracing a branch of the industry not previously included in the committee, namely, the marble industry, so that now the granite, limestone and marble industries are well represented on this committee. Steps to extend further the representation of the committee were taken.

The committee has adopted the following program of activities:

(A) Uniform nomenclature applying to the stone industry;

(B) Physical and chemical properties as affecting structural stability and weathering;

(C) Effect of external agencies, including working processes, on the appearance and durability of building stone;

(D) Prescribed tests and standard methods of testing;

(E) Thermal properties and fatigue of stone and the effect of various forms of backing;

(F) Effect of various materials and processes used in handling, setting and cleaning on the appearance and weathering of building stone;

(G) Development of proper specification requirements; (a) Granite; (b) Limestone; (c) Sandstone; (d) Marble; (e) Other Stones;

(H) Names and definitions for stone finishes;

(I) Structural Integrity of stone after subjection to fire;

(J) Preservation and maintenance of old stone structures;

(K) Resistance to abrasion under various conditions of usage.

A new sub-committee on Methods of Testing was appointed to study existing test data in the methods of testing stone now in use. The report of the Sub-Committee on Data, which has been at work since the last meeting, including an appended report on weathering of stone, was received and discussed in detail. Certain of its several recommendations were then acted upon and others tabled for later consideration. Arrangements were then made for securing funds necessary to finance such further work of compiling a bibliography and a working file of data as was found necessary in planning the actual series of test studies on physical properties and weathering of building stone that the program of this committee includes.

F. Y. Joannes, Architect, is chairman and H. S. Brightly, Director Architects Service Bureau, Indiana Limestone Company, is secretary of this committee.

Railways Adopt Water-Cement Ratio

The American Railway Engineering Association officially adopted a specification for proportioning concrete based on the water-cement ratio law of strength at its annual convention at the Palmer House, Chicago, March 10. This specification was prepared and presented for adoption by the Association's Masonry Committee of which C. C. Westfall, bridge engineer of the Illinois Central Railroad, is chairman, and Job Tuthill, assistant chief engineer of the Pere Marquette Railway, is vice-chairman.

The adoption of this specification by the American Railway Engineering Association marks the abandonment of the 1:2:4 and other arbitrary mixes that have been in use for many years. Instead, the ratio of water to cement is specified, and the proportions of sand and stone are largely left to the discretion of the individual engineer. According to this law, the strength of concrete, within the limits of plastic, workable mixes, is inversely proportional to the amount of water used. By applying this law, engineers can secure concrete of a specified strength within given limits.

This specification, by its adoption on March 10, will become recommended standard practice for all railroads in the United States and Canada and will appear in the Association's Manual of Recommended Practice. A new specification for portland cement was also accepted. This specification was recently adopted by the American Society for Testing Materials and was prepared by Committee C-1 of that Society. C. C. Westfall, J. J. Yates and M. Hirschthal, who are members of this Committee, also belong to the Masonry Committee of the American Railway Engineering Association.

ROCK GRINDING PHENOMENA

By A. M. Gaudin*

DISINTEGRATION, that is to say, crushing, grinding and pulverizing, form an important stage in a great many industries. They have, because of this, attracted a great deal of attention. Therefore, it seems remarkable that the large number of researches which have been made on these processes have not reached the point of establishing any law governing these phenomena. Often, even, the results have been as contradictory as possible, as, for example, those bearing upon the yield of crushing or of grinding.

It has seemed to us that the failures have been caused by the misunderstanding of three fundamental questions:

1. The product resulting from the grinding depends on the structural characteristics of the rock ground.

2. Every crushing process involves, simultaneously, an action which limits the maximum size of the particles produced.

3. That portion of the ground rock which passes the finest sieve (in general a 200 mesh sieve) is of capital importance. The structural characteristics of the rock to be ground influences in marked fashion the proportions of the particles of the different sizes in the product. Figure 1 shows the difference between the sizing tests of vein-quartz and of schist ground in the same way. This diagram is sufficient to show the necessity of limiting the researches, in the first place, at least, to a typical rock.

In this connection it is interesting to emphasize the fact that the rocks must be grouped, from the viewpoint of their disintegrating, into two large classes: the homogeneous rocks, where the fracture passes, with the same ease, across the grain and between it, and the heterogeneous rocks where the fracture passes, preferentially, along the line of cleavage. The type of homogeneous rocks is vein-quartz; that of heterogeneous rocks, the schist, the marble slightly altered by inclemencies of the weather, and, in general, the greater part of the minerals.

Every crushing involves simultaneously an action limiting the largest size of the particles produced, for the crushing is ended when a surface, a line or point comes near another surface, line, or point, forcing a deformation and a breaking of the solid to be crushed, up to a certain state of proximity. This maximum proximity of the grinding elements is fixed by the construction both of the jaw-crushers, the gyratory crushers, the disc crushers or the crushing rocks. It is limited by the presence of particles smaller than the particles of largest size in the rod mills, in such a way that the large particles become crushed more readily than the smaller ones. This approach of the crushing elements is limited, although in less obvious fashion, in the ball mill's. In the steam-mills three actions are found which limit the largest size of the product, viz., the protective action of the large particle as in the crushing rocks, the classifying action of water, and the sifting.

Of the three reasons mentioned above as causes of the contradictions at which one arrives in going over the results of disintegration, the most important, we believe, is the lack of appreciation of the enormity of the variation in size covered by the particles going through a 200 mile sieve. If the tiniest grains passing through such a sieve are represented as having the size of grains of ordinary sand, the largest particles passing through the same sieve would have the size of the Eiffel tower! It is hardly conceivable that the attention of investigators of the grinding phenomena should not have been called to this point which is of great significance, and the only explanation is that these particles are of an order of size where one's sense of perception ceases to seize the differences; that would be evident in other degrees of magnitude.

Keeping in mind the considerations which we have just indicated, a large number of experiments were conducted at the laboratories, on mechanical preparation of the minerals; during the course of the last three years, upon quartz, type of homo-

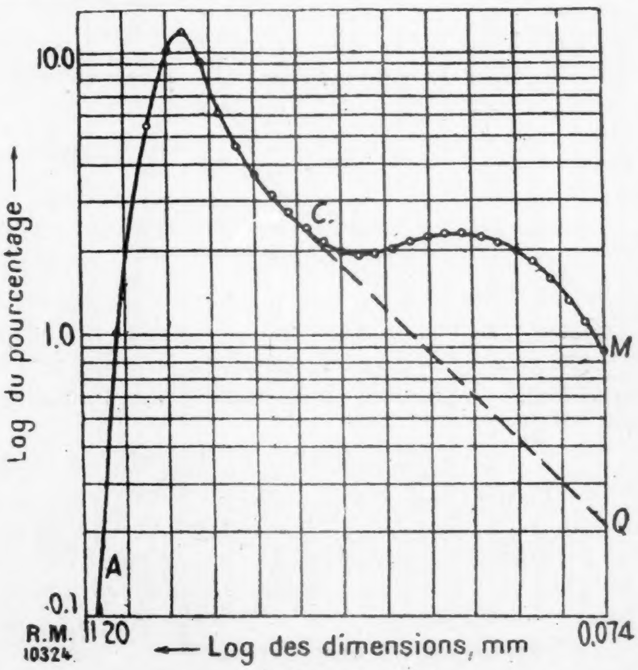


Figure 1.
Curve ACM + 18.85 mm. — 22.43 mm. of Manhattan Schist.
Curve ACQ + 18.85 mm. — 22.43 mm. of lode-quartz crushed by roll crushers.
Deviation 5.6 mm.

*Revue de Metallurgie.

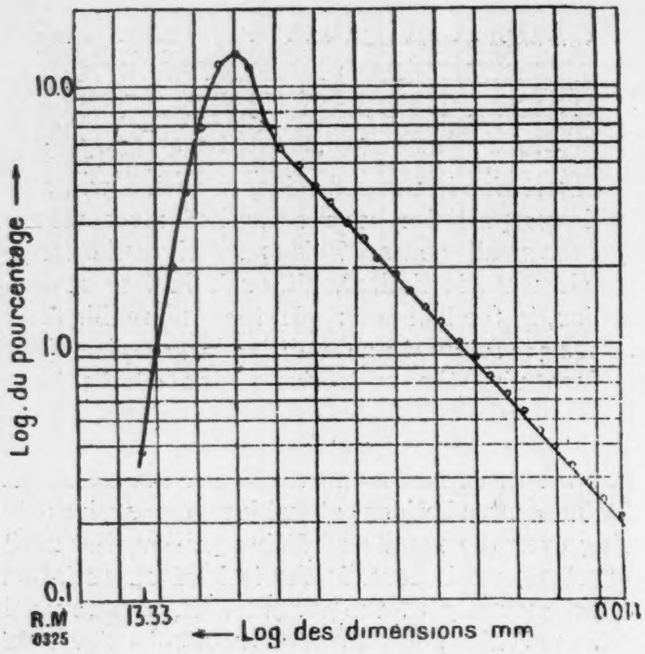


Figure 2.
Supply quartz. — 18.85 + 13.33 mm. crushe dby roll crushers, deviation 5.6 mm.

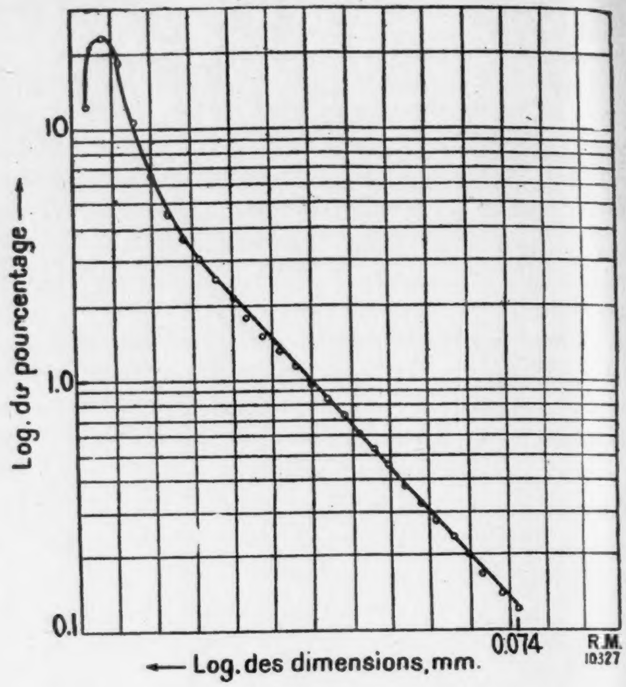


Figure 4.
Supply of galene. — 9,423 + 6,680 mm. crushed by roll crushers, deviation 5.6 mm.

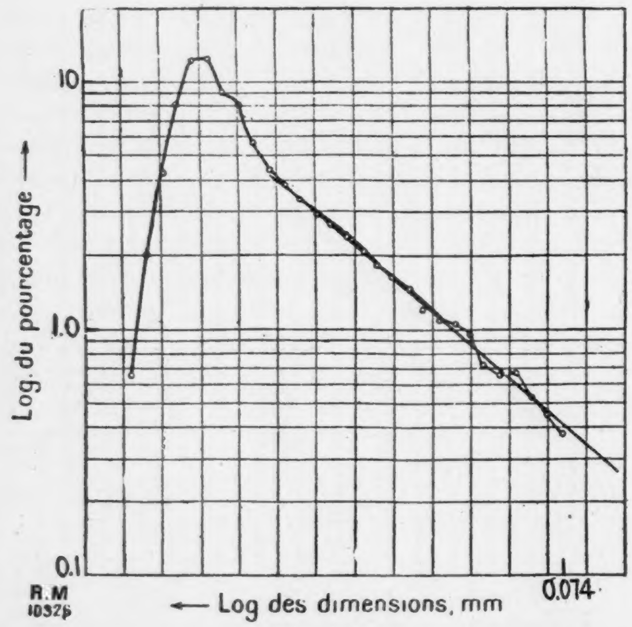


Figure 3.
Supply granite from Stony Creek. — 22.43 + 18.85 mm. crushed by roll crushers, deviation 5.6 mm.

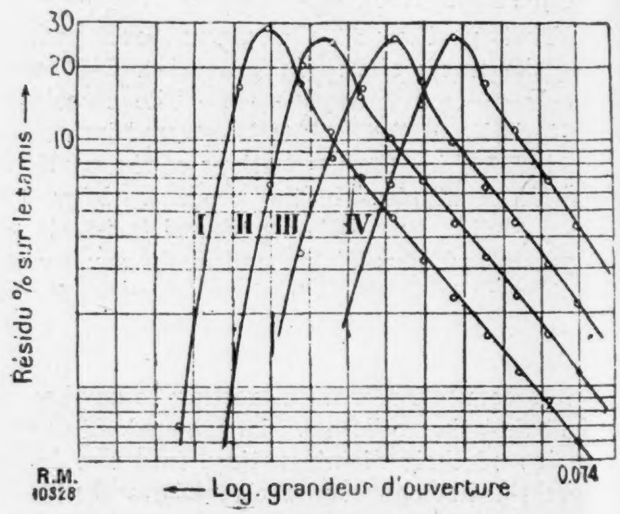


Figure 5.
Supply: Quartz of various lyes, crushed by roll crushers, of different deviations.
Curves.
1. Particles passing through a sieve of 2-3.
2. Particles passing through a sieve of 4-5.
3. Particles passing through a sieve of 8-14.
6. Particles passing through a sieve of 20-28.

geneous rocks, and upon the mica-Schist of Manhattan, a type of heterogeneous rock, with the most diverse grinders. The results of these experiments have made it possible to formulate the following laws:

1. If a product composed of particles of rock structurally homogeneous is crushed, there results, thereby, a product in which the relation between the percentage by weight of the particles of different sizes and the sizes themselves follows a well defined mathematical law. This is not true of rocks structurally heterogeneous.

2. In the breaking of homogeneous rocks, the cleavage takes place by a fracture across the particles rather than by wear, except in the cases of the ball mills where the relation of the diameter of the particles to be crushed to that of the balls exceeds a critical limit.

3. In the case of crushing in a ball-mill where the relation of the size of the particles to the size of the balls exceed the critical relation, that is, one which may be judged with accuracy, the particles are worn away and not broken, giving as a product large particles rounded off with particles very fine in comparison, of which the size is in a definite relation to the size of the balls.

4. The product of the grinding of a heterogeneous rock contains a large proportion of particles which have the size of particles composing the rock than would be contained in a homogeneous

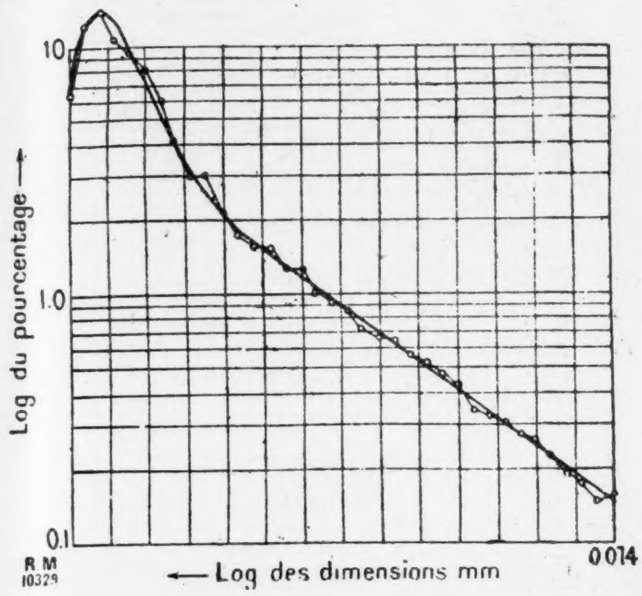


Figure 6.
Supply of granite from Stony Creek + 75 mm. — 50 mm. Crushed by a jaw-crusher of Dodge Type.

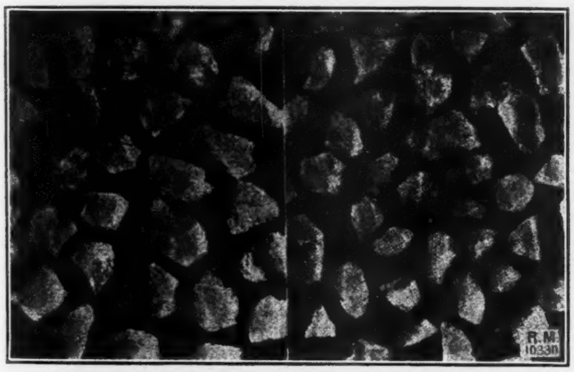


Figure 7 Figure 8

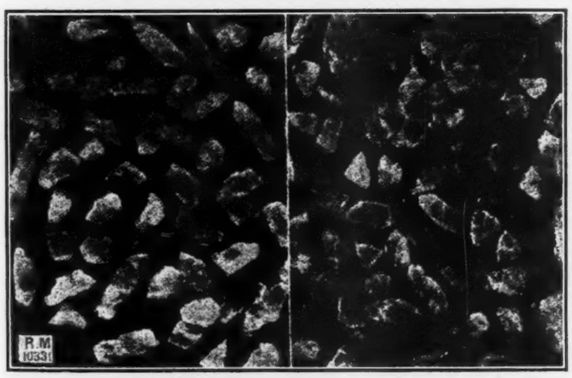


Figure 9 Figure 10

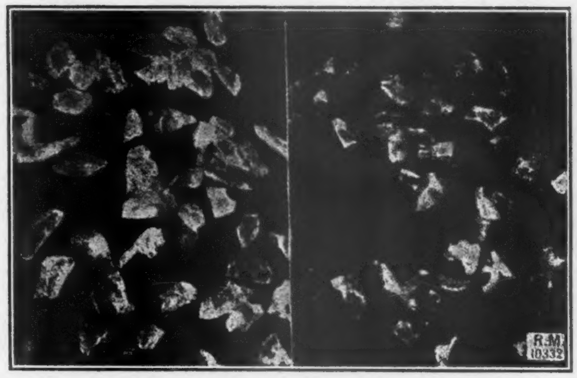


Figure 11. Figure 12

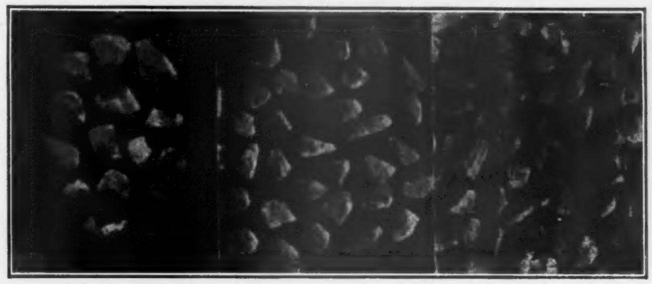
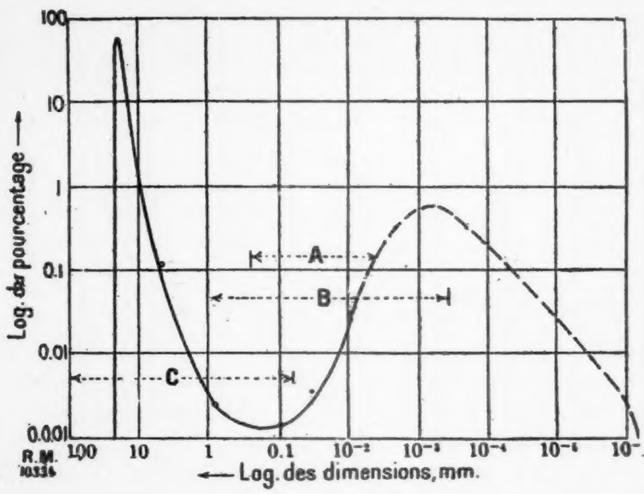


Figure 13 Figure 14 Figure 15



Figures 16
Supply of quartz + 18.85 — 22.43 mm. worn by mutual rubbing in a grinding mill during 6 days.
Classification: A, from setting, leaving sediment. B, from the microscopic study, C, from sifting.

rock which had been subjected to exactly the same treatment.

The operation of a crusher can be judged in a qualitative way by the shape of the particles of the product ground and quantitatively by the proportion of the particles of varying sizes. Two graphic representations of the sizing tests have been made use of, that in which the percentage corresponding to a certain size and the logarithms of that size are the two coordinates, and that in which the logarithms of the percentage corresponding to a certain size and the logarithm of that size are the coordinates. To abbreviate, we shall call them respectively half-logarithmic and logarithmic representations. That last one, especially, has been very useful. The figures 2, 3 and 4 represent the sizing tests of the varied products obtained with the cylindrical mills with the same variation between the cylinders. Figure 5 represents the sizing tests from the grinding of quartz with the cylindrical mills of diverse variations. Figure 6 represents the results obtained from a Dodge type jaw-crusher upon granite. The similarity of the results demonstrate a similarity of causes, that is to say, that the jaw-crushers and the crushing rolls operate in the same identical manner. The photographs

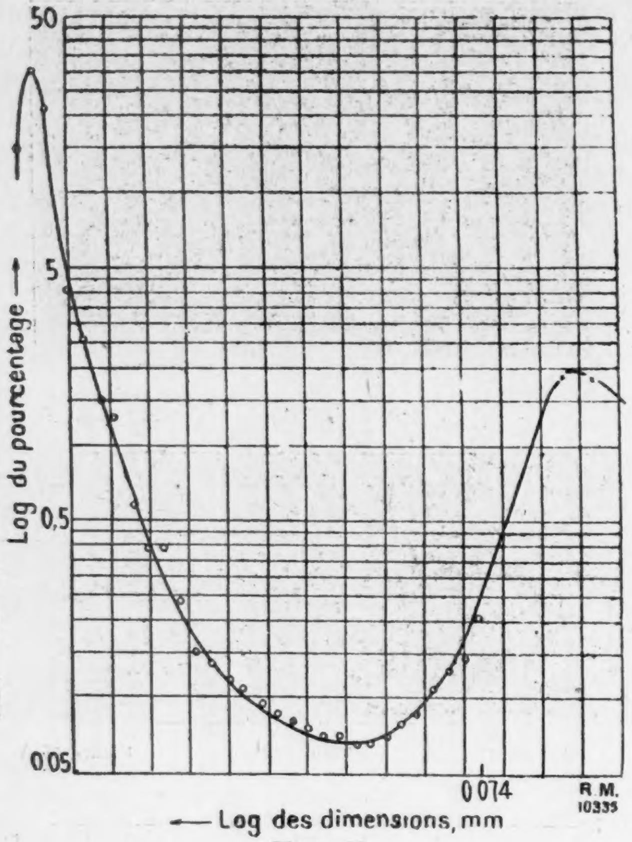


Figure 17

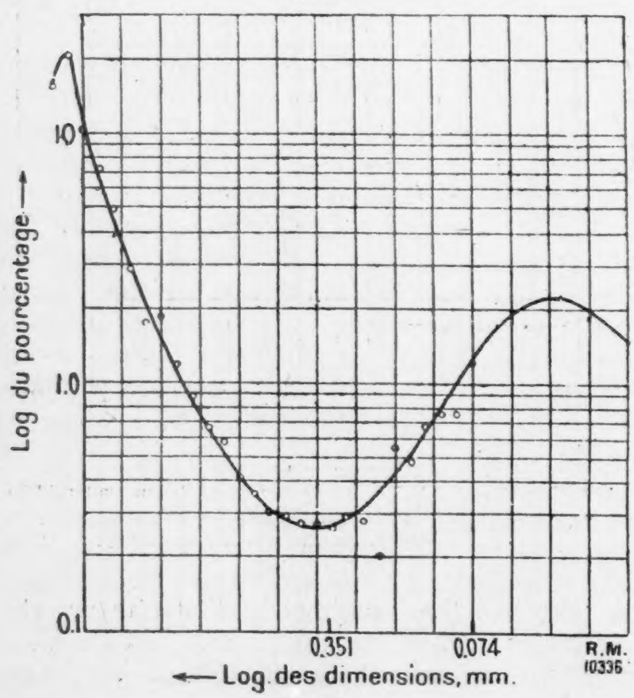


Figure 18

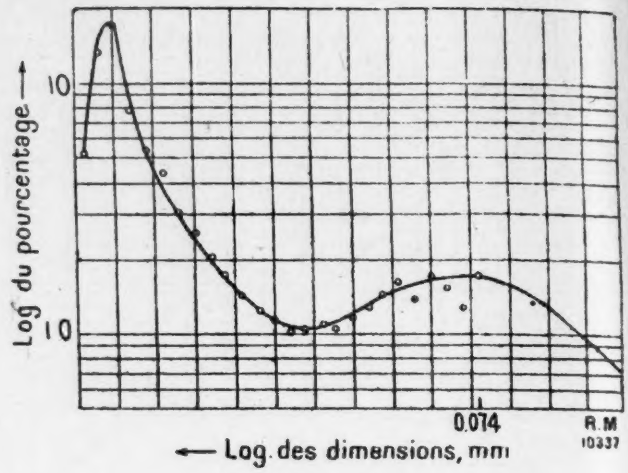


Figure 19

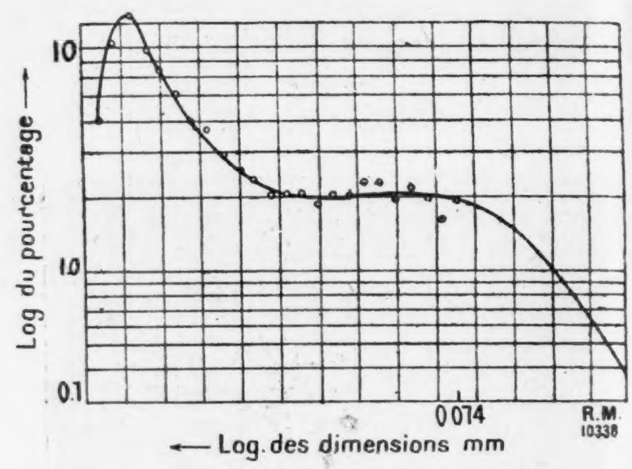


Figure 20

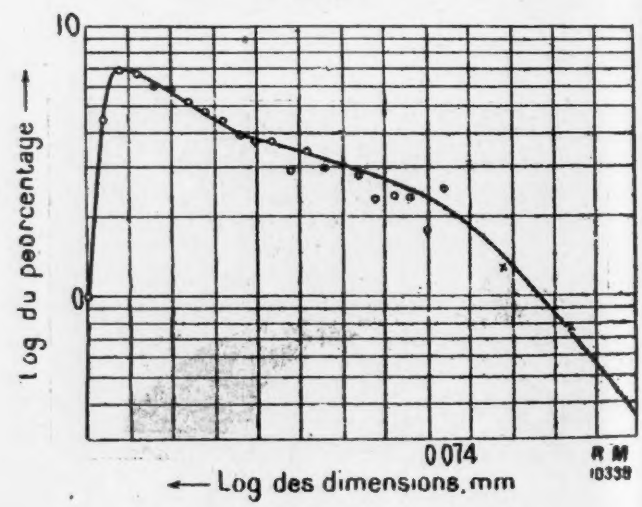


Figure 21

Figures 17-24.
Supply 2,500 g. of pulverized quartz, 4 hours in a ball grinding mill, with 55 balls of ⅞ of an inch, weighing 3,500 grams

balls. Figure 16 indicates the extreme thinness of the particles brought about by wear and tear and (figures 7 to 12) show well the angularity of the particles and justify the assumption that in the machines the fracture takes place across the grain. The figures 13 to 15, on the contrary, show that the wear and tear play a part in certain cases. These photographs represent particles which have worn each other away, in a ball mill deprived of the possibility of producing particles in this way of colloidal dimensions.

Among the cylindrical mills the roll grinders appear to resemble sufficiently well the cylindrical crushers, that is to say, that the particles are broken in them by fracture and not by wear and tear. The ball mills on the contrary, break the particles by fracture only when they are smaller than a certain critical dimension. The figures 17

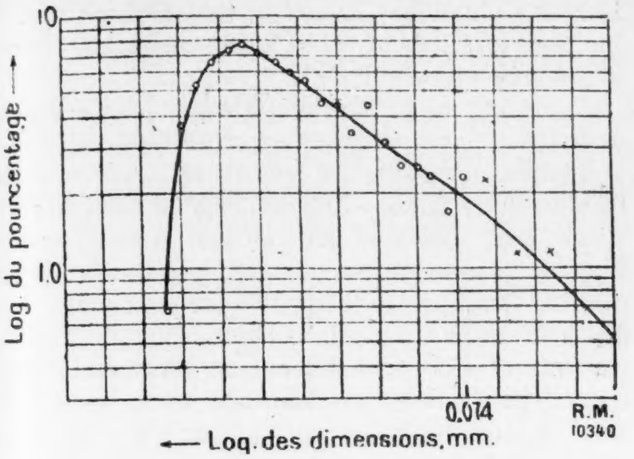


Figure 22

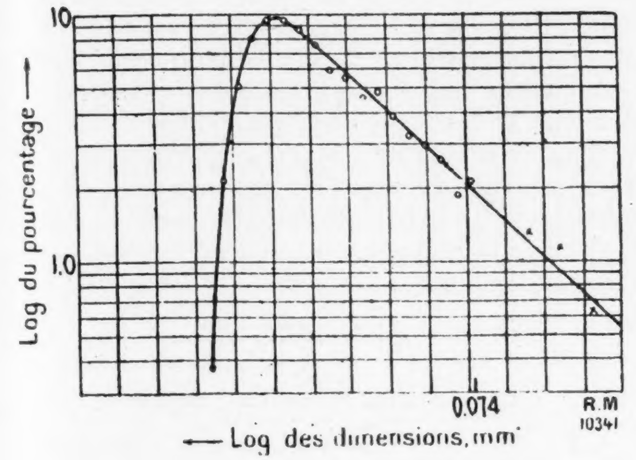


Figure 23

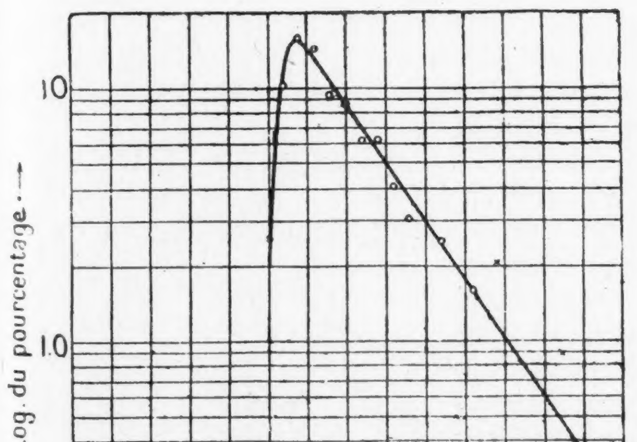


Figure 24

to 24 and the photographs 25 to 29 show that in conjunction with the change in the form of the graph of the sizing tests a change of form is produced in the large grains, which are rounded off and worn, when the dimension of the balls is not

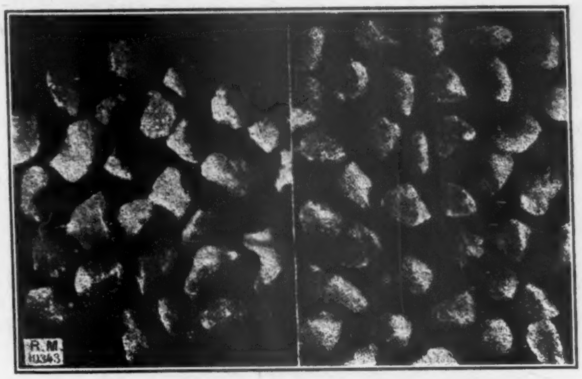


Figure 25 Figure 26

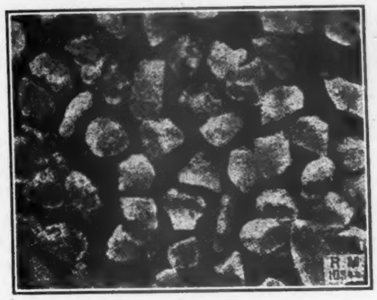


Figure 27

Figures 25 to 29.

Photographs of particles of quartz of the greatest size obtained in the experiments represented by the figures, etc.

sufficient to wear away the particles. This proves the double function of the ball mill which is to break and to wear the particles, one or the other of these functions preponderating according to the relative dimensions of the balls and of the particles of rock. The presence of the straight line in the right of the logarithmic graph of the sizing tests is of great theoretical importance for it makes it possible to determine by definite integration the specific surface, the size of the medium surface, the number of particles contained in a given volume, and various other interesting quantities. The most important result is always the possibility of determining for the first time the absolute yield—and not a relative yield. This yield is obtained as follows:

The surface developed by the grinding being calculated as has been indicated above, and the superficial energy of the ground matter being known (920 ergs to a sq. cm. for the quartz), the total energy recovered under the form of pulverizing is obtained, by multiplication. The spent energy being determined in the ordinary way, the output is found by a simple division of these quantities. The figures obtained are of the order of size of 1%.

The heterogeneous rocks, as has been said above, break themselves preferentially along the line of cleavage in such a way that more particles are produced, having the average size of the particle in the rock, than are produced of that size in a homogeneous rock. Practically, this advantage may be repeated in grinding by stages of small reduction in size. Such a process would bring about less fine particles than that of pulverization by one or two

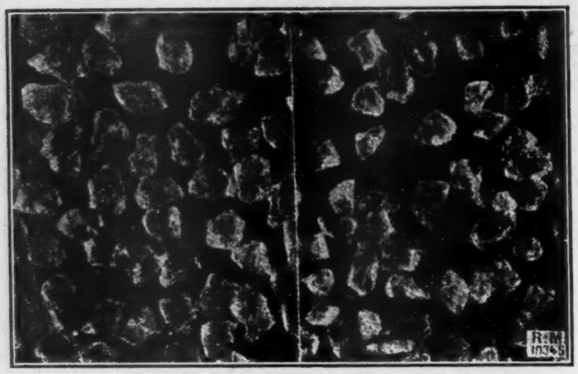


Figure 28 Figure 29

grand stages, and, in consequence, is preferable in those cases in which it is desired that the mineral should be treated by concentration by gravity.

Portland Cement In Argentina

The use of portland cement has greatly increased in Argentina during the past five years. The country now has three plants manufacturing cement, while receipts of foreign cements have increased from approximately 163,000 metric tons in 1921 to 371,000 in 1925 and according to one estimate 186,520 during the first six months of 1926.

The United States has only a small share of the importation but an American Company is very active in the production of cement in Argentina. This concern is the most important of the three plants operating there and has an annual capacity of 735,000 barrels, compared with 70,000 and 35,000, respectively, from the two other concerns.

The entire consumption of portland cement in Argentina in 1924 was about 413,000 metric tons, of which 138,715 tons were manufactured locally. Of this amount the American company produced 128,715 tons. In 1925 the domestic manufacturers supplied about one-fourth of a total consumption of 500,000 tons, the American company furnishing 119,000 tons. For the first half of 1926 the consumption has been estimated at 268,135 tons, 81,615 being Argentina manufacture and 76,615 from the American company. From these figures it would seem that approximately 70 per cent used in Argentina is imported and 30 per cent manufactured in the country.

Valuable Soda Beds

Natron, which is the natural crystal soda of the same chemical composition, and which is not commonly found native, occurs in considerable quantity in British Columbia, in small, undrained lakes which occupy shallow depressions over the southern portion of the green timber plateau, just to the north of the village of Clinton, one of the integral plateaus forming the great interior plateau of British Columbia, situated in the southern part of the province, about midway between the Rocky Mountains and the Pacific.

According to present knowledge, practically all of the soda lakes of commercial importance, eleven in number, are situated within an area of about thirty square miles. The majority of the lakes are within four miles of the railroad, and all except two are within thirteen miles. The lakes are small, ranging from five to thirty-five acres in area. The depth of brine in the lake containing the greater amounts of soda does not exceed three and a half feet. The available tonnage of natron in nine of the lakes examined is on a preliminary estimate, about 220,000 tons. The largest single deposit contains about 70,000 tons.

In all except two of the lakes the soda is in solution during the greater part of the year, but when the concentrated brine is chilled by the cool autumn weather the soda crystallizes out in the form of a natron. If the brine were not chilled and concentration by solar evaporation were to continue, the resulting deposit would be the mineral, trona, a mixture of the carbonate and bicarbonate. This is the usual form in which soda occurs in natural deposits throughout the world.

Per Capita Wealth Increase

The Credit World has grouped a few figures showing increase in five years of Savings Accounts, Building Loans and Insurance.

	1920	1925
Number of automobiles	9,231,941	19,954,347
No. of savings depositors	22,415,148	43,850,127
Amount of all savings deposits .	$15,314,061,000	$23,134,052,000
No. of Bldg. & Loan Ass'n ...	8,633	11,844
Membership in Bldg. & Loan Associations ..	4,962,919	8,554,352
Assets of Bldg. & Loan Ass'n ..	$2,519,914,971	$4,765,937,197
Premium Income of American Life Insurance Companies ...	$1,384,938,970	$2,371,921,237
Assets of American Life Insurance Companies	$7,319,997,018	$11,643,759,810
Number of policy holders	66,499,000	99,250,000
Average wealth per capita in the United States	$2,819	$4,406

THE WATER CEMENT RATIO AND DENSITY OF CONCRETE

By F. R. McMillan
Manager Structural and Technical Bureau, Portland Cement Association*

IT has often been remarked that in the discussion of the design of concrete mixtures too much attention has been paid to the strength and too little to density and durability. It is the purpose of this paper to present a brief discussion of these questions and to show how they are interrelated to the strength and water-cement ratio.

Density Defined

In this discussion the word "density" will first be used in the usual significance and later modified to represent more truly the quality which is generally understood by the term. The usual meaning of density as applied to concrete mixtures is the proportion of the solid matter to the total volume of concrete. That is, it is the sum of the absolute volumes of the aggregate and the cement in the unit volume of concrete. The complement of this is sometimes referred to as the voids. This definition of density is easily comprehended from figure 1. In many of the discussions of laboratory tests of concrete there will be found tabulations of the densities and voids, the terms being used as just defined.

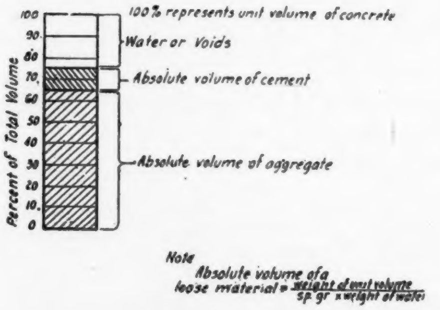


Figure 1.

Simple Conception of Concrete

The problems involved in the study of concrete mixtures, particularly with reference to density, can be greatly clarified by a conception of concrete as an aggregate mass thoroughly incorporated in a cement paste. This conception can be visualized from figure 1, assuming for this purpose that a unit volume of freshly mixed concrete is represented. The space not occupied by the aggregate is occupied by the paste. Now if the mixture is plastic, that is, not granular, the space not occupied by aggregate must be completely filled with the paste. Under this condition there are no air voids, except possibly some small air bubbles here and there entrained in the sticky paste, and the aggregate particles are completely floated in the paste. That this is true can be shown by a comparison of the measured volumes of concrete produced from a given mix with the volume obtained by adding together the absolute volumes of the aggregate, cement and water. This has been done for many mixes and the two volumes found to agree, showing that no considerable amount of air is entrained.

Quantities of Materials Required

The conception of concrete symbolized in figure 1 shows that so long as the concrete is plastic the total volume produced is equal to the sum of the absolute volumes of the aggregate, cement and water. This suggests a method of computing the quantity of cement and aggregates required for a unit volume of concrete. By this method it is only necessary to compute the absolute volumes of the several materials and their total, from which the respective amounts of each material required for a unit volume of concrete can readily be obtained. For a given volume of a granular material, the absolute volume is equal to its weight divided by the product of its specific gravity and the weight of a similar volume of water.

A method of estimating the quantities of materials differing somewhat in detail of application but based on this same principle is given by Mr. Stanton Walker in an article in the National Sand and Gravel Bulletin for September, 1926. The feature of interest in this article is the comparison of the measured and computed values of the amount of cement required in concrete for a large number of mixes reported in various bulletins of the Structural Materials Research Laboratory and the University of Illinois. The two sets of values are in almost perfect agreement for all plastic mixes, showing, as pointed out above, that in these mixes the air voids are insignificant.

Strength of Concrete Determined by Quality of Paste

Under the conception of concrete as an aggregate mass thoroughly incorporated in a cement paste it is possible to explain many of the experimental facts which otherwise are not so easily visualized. The water-cement-ratio strength relation is now so thoroughly established and widely

*Presented before the Western Society of Engineers, December 6, 1926.

recognized that it can be accepted as a law for the purpose of this discussion. This law is best stated as follows: For given materials and conditions of manipulation the strength of concrete is determined solely by the proportion of the quantity of mixing water to the quantity of cement, provided that the mixes are plastic and workable and the aggregates clean and structurally sound. Table 1 gives a good illustration of this law, where the strength for any water-cement ratio will be seen to be in close agreement regardless of the mixture, while for any mix the strength falls off rapidly as the water-cement ratio is increased.

In the light of this law the strength of the concrete is seen to be determined by the amount of water in the paste. The use of more or less aggregate or of aggregates of different gradings only affects the plasticity or workability and the economy. Increased plasticity can be obtained either by the use of more paste, which adds to the cost, or by a paste of larger water content, which reduces the strength.

Table 1—Tests of Concrete of Constant Water-Ratio

(Data from Series 186)

Compression tests of 6x12 inch cylinders.
Aggregate: Sand and pebbles from Elgin, Ill., graded 0 to 1½ inch.
Cement: A mixture of four brands of portland cement purchased in Chicago.
Plasticity of concrete was measured by means of the slump and flow test.
Specimens cured in moist room at 70° F. until test; tested damp.
Age at test 28 days.
In general each value is the average of five tests made on different days.
Details of tests not included in this report.

Mix by Volume (in terms of dry and rodded volumes of aggregates)	Compressive strength at 28 days—lb. per sq. inch for different quantities of mixing water U. S. gallons per sack (94 lbs.) of cement.								
	5	5½	6	6½	7	7½	8	8½	9
1—1 —1	5250	4520	3960	....	....	....	....	....	....
1—1 —2	5420	4680	4080	3450	....	....	....	....	....
1—1 —3	5400	4710	3930	3140	....	....	....	....	....
1—1 —4	....	....	3810	2800	....	....	....	....	....
1—1½—0	5380	5070	4300	3970	....	....	....	....	....
1—1½—1	5170	....	....	....	....	....	....	....	....
1—1½ 2	5210	4760	4370	3770	3420	2920	....	....	....
1—1½—3	....	4780	4650	3990	3540	2620	2380	....	....
1—1½—4	....	....	4370	3870	3370	2590	2040	....	....
1—2 —0	....	4150	4090	3740	3340	....	....	....	....
1—2 —1	....	4340	4010	3660	....	....	....	....	....
1—2 —2	....	....	4320	3640	3160	3060	....	....	....
1—2 —3	....	....	3670	3910	3490	3140	2760	2500	....
1—2 —4	....	....	....	3630	3520	3210	2820	2380	1960
1—2 —5	....	....	....	....	....	2750	2870	2170	1920
1—2 —6	....	....	....	....	....	2650	2400	2250	1870
1—2½—0	....	....	3560	3510	3430	3210	....	....	....
1—2½—1	....	....	3590	....	....	....	....	....	....
1—2½—2	....	....	....	3480	3470	3350	....	....	....
1—2½—3	....	....	....	3360	3310	3090	2950	....	....
1—2½—4	....	....	....	....	3100	2950	2730	2790	2460
1—2½—5	....	....	....	....	....	2740	2440	2410	2240
1—2½—6	....	....	....	....	....	....	2360	2280	2040
1—3 —0	....	....	....	....	....	2980	2710	....	....
1—3 —3	....	....	....	....	....	1740	2510	....	....
1—3 —4	....	....	....	....	....	2580	2460	2320	....
1—3 —5	....	....	....	....	....	2320	2460	2300	2100
1—3 —6	....	....	....	....	....	....	2320	2230	2020
	5300	4630	4050	3590	3380	2820	2510	2360	2080

Impermeability of Concrete Determined by the Quality of the Paste

The data covering permeability of concrete are very meagre in comparison with those showing the strength in compression. Such data as are available, however, clearly indicate that the water-tightness is directly affected by the quantity of mixing water. The best data available on the permeability of concrete are the results of tests by Prof. M. C. Withey at the University of Wisconsin. These are published in Bulletin No. 1245, "Permeability Tests on Broken Stone Concrete," 1923. Among the conclusions drawn by Professor Withey from these tests relating to the production of water-tight concrete are the following: Mixes should be of a plastic consistency, of a fair degree of richness, carefully placed and thoroughly cured. Showing the relation between impermeability and compressive strength, he states as follows: "For properly placed and cured broken stone or gravel concrete the permeability decreased as the compressive strength increased until the latter reached 2,500 pounds per square inch. Concretes of this strength were watertight."

Figure 2 has been prepared from the data in tables 6 and 8 of Professor Withey's report. While the data are not treated in the bulletin with respect to water-cement ratio, sufficient information is given for the preparation of this figure. In the lower diagram of figure 2 are plotted the relation between average leakage for a 50-hour period under pressure of 40 pounds per square inch and the water-cement ratio, expressed in gallons per sack of cement. In the upper figure the compressive strengths are shown for the same mixes.

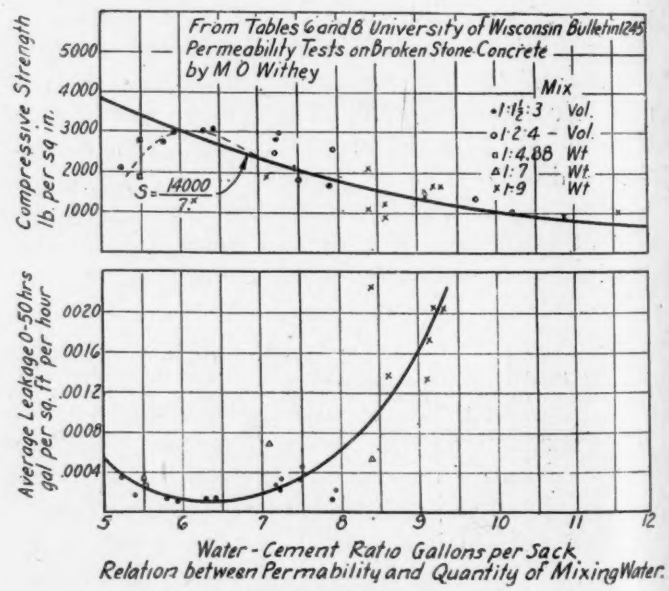


Figure 2.

In the diagram for compressive strengths the curve shown is that given by Professor Duff A. Abrams in many of his publications as representing the average relation between the compressive strength of concrete at 28 days and the water-cement ratio. In the equation shown the water-cement ratio (an exponent) is the volumetric ratio, a water ratio of 1 corresponding to 7½ gallons or 1 cubic foot of water per sack of cement. At the left of the diagram a dotted curve departing from Abrams' curve is drawn to represent more accurately Withey's tests. This shows a falling off of strength as the water-cement ratio is reduced. This is because Withey used fixed mixes of three consistencies—dry, medium and wet—and it is the dry mixes in each case that show the falling off in strengths. This is in complete accord with

Abrams' tests, for he has repeatedly called attention to the fact that it is only the plastic mixes that follow the water-cement ratio strength law.

The curve representing the relation between leakage and water-cement ratio rises somewhat to the left, showing an increase in leakage with the dryer mixes. This is in accordance with Professor Withey's conclusion that only the plastic mixes were water-tight. These tests, it should be remembered, were not planned as a study of the water-cement ratio, but as a study of the usual arbitrary mixes of varying consistency. When the data are studied, however, it is clearly apparent that the most important element is the quantity of water used in each sack of cement.

Reverting to figure 1, it can be seen how it explains the permeability tests. Any water finding its way through the concrete mass must do so through the cement paste separating the aggregate particles (assuming impervious aggregates). The permeability of this paste is directly affected by the amount of water used, for any water not actually combined with the cement through hydration must later escape as free water, leaving open pores to provide passage of the water under tests.

Permeability a Cause of Disintegration

In the Report for 1925 of Committee E-6, "Destructive Agents and Protective Treatments," of the American Concrete Institute, appear the results of a rather extensive field investigation of the causes of disintegration in Concrete. In the review of the cases cited the Committee states that "the effects observed were largely due to faulty manipulation of the materials" and that "permanent structures can be achieved by the production of concrete that is impervious to moisture." They further state that the principal cause of porous concrete in the structures studied was the use of an excess quantity of mixing water.

Importance of Curing on Density

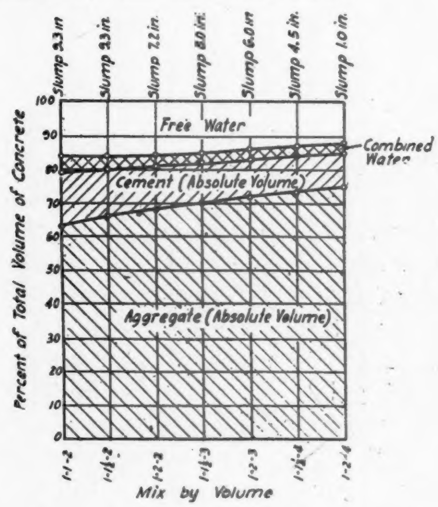
In taking into account the effect of curing on the density of concrete, it is necessary to redefine the term "density." In figure 3 are shown a number of concrete mixtures with constant water-cement ratio, plotted in the same manner as in figure 1, with the exception of an additional area to indicate the amount of water which enters into combination with the cement. Since the water actually enters into the permanent internal structure of the concrete it is evident that it should be included with the solid matter in determining the density.

The amount of water which will be taken up in hydration is a function of the period and conditions of curing. It may vary from a very small amount in specimens cured for only a few hours to perhaps 40 or 50%, of the absolute volumes of the cement for long continued favorable curing. The amount of this combined water is determined by oven drying, at boiling temperatures, a sample of known weight and composition. Water not driven off is taken as the combined water. This should not be confused with the amount held in suspension when subjected only to air drying at ordinary temperatures.

The importance of including this combined water as part of the solid matter can be seen at once, for the void spaces in the hardened concrete which determine the porosity or permeability of the concrete are only those occupied by the free water. This meaning of density gives a new significance to the matter of curing and further emphasizes the thought that both the strength and impermeability of concrete are determined by the character and quality of the cement paste surrounding the aggregates.

Effect of Grading and Mix on Density

A study of figure 3 shows graphically what has long been noted by students of the problem of concrete mixtures, that the grading of the aggregates does not have such an important effect on density as might be expected. Compare, for example, the densities of 1:2:2 and the 1:1½:4, which range in grading from an oversanded to a harsh combination. The difference of 2% is a very minor matter when thought of in connection with the total voids, as illustrated by the unshaded area.



Density of Concrete of Constant Water-Cement Ratio
Water-Cement Ratio 6½ Gal. per Sack.
All Mixes on Basis of Dry Compact Aggregates.

Figure 3.

The mixes in figure 3 are for constant water-cement ratio and the proportion of free water to paste is the same for all mixes. Thus, the only difference in water resisting value of these different mixes is in the respective amounts of paste. For the two extremes in the diagram these are 36 and 25 per cent of the total volume and the passage of water would be approximately in the direct ratio of these respective percentages. In figure 4 two mixes are plotted in a manner similar to figure 3. Each mix is carried through several water-cement ratios. In these, it will be observed, the amount of paste does not vary much with the different water-cement ratios, but the character of paste, as indicated by the relative proportion of free water, varies materially.

In figures 3 and 4 the differences of workability should not be overlooked. In figure 3, with a constant water-cement ratio and varying mix, and in figure 4, the constant mixes and varying water-cement ratio, the slump varied from 0.1 to 9.3 inches. Naturally these are not all equally placeable. In figure 5 are given a number of mixes with about the same consistency, slump 2.8 to 4.5.

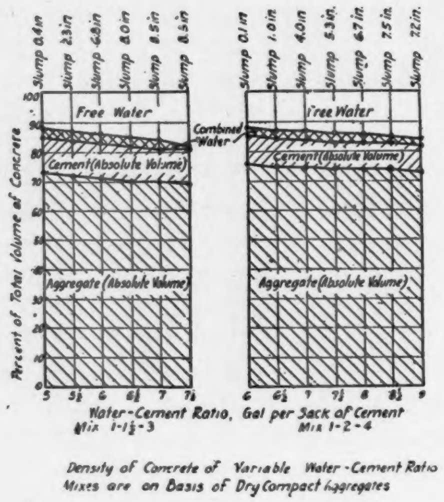


Figure 4.

In this figure it is seen that for a given consistency little is gained, so far as density in the usual sense is concerned, by the use of one mix or water-cement ratio over another. That is, all of these mixes have about the same amount of solid matter in a unit volume of concrete. In those with the low water-cement ratio, that is, the rich mixes, the proportion of free water to the volume of paste is very much less than for those with a high water ratio, that is, the lean mixes. For example, for a mix having 5 gallons of water per sack of cement the ratio of free water to paste is about 39%, while for a mix with an 8-gallon water ratio it is about 64%. These figures are based on the assumption of combined water equal to about ⅓ the volume of the cement. This difference in the porosity of the paste just cited in figure 5 shows the advantage of a low water-cement ratio in the production of impermeable concrete.

Summary

These points relating to concrete placed in a plastic condition and free from honeycomb may be summarized.

Density of concrete should be defined as the proportion of solid matter in a unit volume of hardened concrete. In computing the amount of solid matter, the quantity of water actually entering into combination with the cement should be added to the absolute volumes of the cement and aggregate.

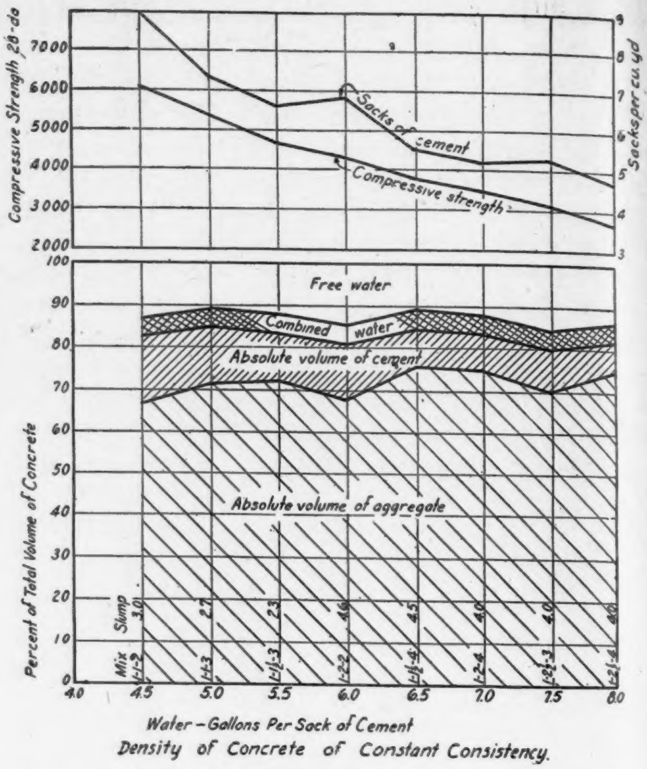


Figure 5.

The density of concrete is not of itself a criterion of its water-tightness. Since for the ordinary (nearly impervious) aggregates the passage of water through the concrete must be through the space occupied by the paste, it follows that the imperviousness, rather than the quantity, of the paste is the determining factor.

The imperviousness of the paste is determined by the amount of free or uncombined water. The amount of uncombined water is a function of both the water-cement ratio used in mixing and the extent of the curing. These considerations lead to the conclusion that concrete to be watertight must be placed in a plastic condition, must have a low water-cement ratio and must be thoroughly cured. This conclusion is supported by all the facts of experiment and experience.

Canada Is Building Roads

British Columbia, Canada, plans to spend $6,341,718 in 1927 on road extensions, highway maintenance, bridge replacements and construction. The Public Works Department estimates will provide $2,341,718 and the remaining $4,000,000 will be obtained by special loan.

The Nova Scotia Department of Highways spent $2,118,825.93 on construction and maintenance of roads, bridges and ferries during 1926. Of this sum, $1,609,741.05 went for maintenance. The Department of Highways recommends that $1,319,190 be spent on maintenance of roads alone in 1927. There are 14,413 miles of roads in Nova Scotia at the present time.

COMMENTS ON CONCRETE ROAD CONSTRUCTION

By A. N. Johnson

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IT IS well to state the limitations that have necessarily been kept in mind in the preparation of this paper. The fact that this audience includes so many who have had as much or more extensive experience in concrete road construction than any other group of engineers in the country made the selection of material to be presented all the more difficult. What has been done is to present but a few phases of the subject with which the writer has had some personal contact or experience, and which, at the same time, would be of general interest to this audience. There are, therefore, obvious omissions of many important phases of the subject, the discussion of which is left to others who may participate in the presentation of this topic.

This paper contains a brief outline of the development of the use of concrete for road construction in the past, after which attention is centered upon a few points which are the results of recent developments in the art of building concrete roads. These developments have come about through extended experience on the part of highway engineers, and also as the result of scientific researches and studies which yearly add to the sum of knowledge at the disposal of the engineer.

Concrete road construction, as we know it today, is a very recent development. There are, however, a few scattered instances of the use of concrete in road construction extending back nearly a century. The first was the construction of about one-quarter of a mile of road outside of London on the Highgate Archway Road, where a concrete base was laid in 1828 over which macadam was placed. The next use of concrete noted was for the foundation of an asphalt pavement laid in Paris about 1858. Concrete was first used as the wearing surface of a pavement in Scotland in 1865, and the following year another section was also laid in Scotland. The method of construction of these latter roads is of interest. Concrete was laid in layers of three or four inches, which was rolled and allowed to remain for three days before a second layer was placed. It was recommended that the road should be left for three weeks before opening to traffic, though the engineer reported a week was found to be a sufficient interval.

It is stated that concrete was first used in America as a base for paving in 1888 in New York. A concrete pavement with concrete wearing surface was first built in Wichita, Kansas, but was not a success. The next concrete pavement of which we have record was laid in Bellefonte, Ohio, in 1892. Between 1896 and 1906 a number of concrete streets were laid in Richmond, Indiana. But the use of concrete for highways may well be said to begin with the concrete road laid on Woodward avenue in 1909 by the Highway Commission of Wayne County, Michigan. By 1912 a number of sections of highways had been built in Milwaukee County, Wisconsin, Cook County, Illinois, and some other points in the Middle West, as well as in Wayne County. From this date, the use of concrete for rural highways has developed very rapidly. For a somewhat more extended description of the earlier use and development of concrete highways, a reference may be made to a paper by the speaker in the Proceedings of the American Concrete Institute, Vol. 20, 1924.

The development of concrete roads has been greatly stimulated by research of a high degree of scientific attainment. The highway researches that have come about through concrete road construction have been especially marked. These have been carried on by many agencies, in particular the U. S. Bureau of Public Roads and the various State Highway Commissions, as well as by many universities.

One of these investigations to attract our attention is the series of experiments made by the Illinois Highway Department known as the Bates Road Tests. A full description of the details of these tests and results have been very ably presented before the A. S. C. E. by Mr. Clifford Older, at that time Chief Engineer of the Illinois Highway Commission. His paper was presented January 17, 1924, and appears in full in the Transactions of the Society for 1924, page 1180. This series of tests consists essentially of many types of construction, extending over a distance of two miles, upon which trucks were driven with increasing loads until all of the weaker sections were destroyed. Apparatus for making measurements of the deformation of the concrete road slabs under various conditions of loading were devised, and in general, the results obtained confirm the fact previously ascertained by laboratory experiments as to the elastic properties of concrete to which further mention will be made.

We are concerned here not so much with the descriptive detail of these tests as with the results in so far as they may be usefully applied by the engineer in the construction of concrete roads. Perhaps, one of the most significant facts brought out is the behavior of clay subgrades through attempts to control the moisture content, for it is well known that the bearing power of clay soils varies with the moisture content, the greater this moisture content the less the bearing power.

*Presented at the Thirteenth Annual Conference on Highway Engineering at the University of Michigan, Ann Arbor, on February 15, 1927.

It has been a practice by many engineers in preparing a subgrade through clay soils to resort to expensive side ditches and under-drains in order to reduce the moisture content of the soils. But the result of the careful observations and experiments made, as reported by Mr. Older, indicate these are of very doubtful value. The report discusses in detail that along a 200-foot section a 24-inch drain tile was laid below the subgrade in a trench backfilled with cinders. No difference in the moisture content was noted for a period of three years between the soil of this section and a nearby section not provided with such drains. There is further described a similar experience on another road with different character of clay soil, where tile drains were laid 42 inches under each edge of the pavement for a distance of 1,000 feet. These trenches were also backfilled with cinders. The results here obtained showed that the section provided with tile drain contained actually more moisture, throughout a period of over a year, than under the adjacent undrained pavement. Mr. Older concludes that "to judge from these two examples in which tile drains were of absolutely no apparent value, it is questionable whether such attempts to control the moisture are of any merit whatever in clay soils."

As a result of further observations on the moisture content of the clay subgrade underlying the Bates Test Road, it was found that the moisture content of the subgrade at the time of construction was evidently an important factor in the amount of moisture that may be found in such subgrades, at least for a period of a year or more after the pavement is laid. For example, on a section of the road laid in a rainless period in hot weather, which preceded the construction, it was found that during the following October it reached nearly a point of saturation, whereas another section laid at the time the subgrade contained about 24 per cent of moisture did not, throughout the winter following, show any increase in the amount of moisture in the subgrade. Mr. Older ascribes this result to the fact that if during the summer the moisture content was normal, the clays resisted further saturation; on the other hand, if they were extremely dry when the soil crumbled readily, subsequent absorption to the point of saturation takes place very rapidly. These observations suggest the desirability of thoroughly wetting a very dry clay subgrade upon laying concrete.

The extensive investigations carried on by the U. S. Bureau of Public Roads are in part reported in the Transactions of the A. S. C. E. for 1925, page 264, in an article by A. T. Goldbeck describing in detail the results of numerous subgrade studies. These confirm many of the conclusions arrived at by Older. From these latter investigations, perhaps the most important conclusion to be drawn by the highway builder is that one of the most effective protections against soft clay subgrade is a layer of sandy or gravelly soil (or similar granular material) which has a very low capillarity. This form of construction in particular gives protection against frost action.

Another important result as the outcome of the Bates Road Test was the adoption of a cross section with a thickened edge, using actually a smaller amount of concrete per mile, yet producing a road slab which showed greater resistance to heavy traffic than the usual cross section thickened at the center. The conclusions in this particular from the Bates Road Test were so obvious that within one or two years from the date of the publication of the results, this cross section had been adopted by thirty-nine states. The section designed by Mr. Older is one with an edge thickness of nine inches tapering to five or six inches two feet from the outer edge, the remainder of the slab having a uniform thickness of five or six inches. It was noted that at the end of the traffic test this section remained in excellent condition, and that no damage had occurred which would cause additional maintenance cost.

There is, perhaps, no point in connection with the construction of concrete roads about which there has been more speculation than as to the effect of steel reinforcement. Many experimental sections of roads reinforced in various ways have been constructed, as well as extensive stretches of road in which steel reinforcement of various kinds have been employed. There were, however, at hand no comprehensive digests of the results until such a study had been undertaken by the Highway Research Board in 1925, when, through the cooperation of the manufacturers of steel reinforcement, there were made possible sufficient funds to carry on a special investigation, which was done and a report made. This report forms part 2 of the Proceedings of the Fifth Annual Meeting of the Highway Research Board, December, 1925.

An examination of this report is necessary before adequate idea may be had of its extent. These comments are but fragmentary, and made for the purpose only of exciting sufficient interest for you to examine, at first hand, the report itself.

A few of the conclusions drawn, ably supported by adequate data, are presented in the report as a summary of conclusions, and are repeated here. From them many useful suggestions of practical value to the highway engineer will be found.

1—"The amount of cracking and subsequent disintegrating is a function of time; thus, the rate of cracking is a measure of the life of the pavement.

2—"The data show that steel reinforcement reduced the rate of cracking and thus increased the life of the pavement. This applies to both concrete pavements and other pavements laid upon a concrete base.

3—"Crack reduction is more economically accomplished by the use of steel reinforcement than by additional thickness of concrete.

4—"A greater reduction was afforded by small steel members closely spaced than by larger members wider spaced.

5—"Increasing weight of mesh from 25 to 56 lbs. per 100 sq. ft. considerably reduced cracking.

6—"Mesh reinforcement, 25 to 56 lbs. per 100 sq. ft. reduced cracks 35 to 70 per cent in pavements of like thickness.

7—"Mesh reinforcement, 25 to 56 lbs. per 100 sq. ft. and bar mat reinforcement 64 lbs. per 100 sq. ft.—25 per cent longitudinal—reduced cracks more than one additional inch of concrete; but one additional inch of concrete reduced cracks more than bars (42 to 48 lbs. per 100 sq. ft.) placed transversely only.

8—"With good crushed stone aggregate, 56 to 90 lbs. per 100 sq. ft. mesh reinforcement, or 170 lbs. per 100 sq. ft. bar reinforcement, 50 per cent each way, caused a reduction in combined transverse and longitudinal cracks equal to that indicated for 2 inches additional center thickness.

9—"Mesh reinforcement of 38 lbs. per 100 sq. ft. has been effective for a thin layer of concrete laid as resurfacing upon an old concrete road.

10—"One additional inch of edge thickness reduced corner cracks more than mesh reinforcement 25 to 56 lbs. per 100 sq. ft. or 3/8 to 3/4 inch bar reinforcement; but progressive destruction following the appearance of corner cracks was arrested by steel reinforcement.

11—"All types of steel reinforcement across cracks tended to hold together fractured slabs.

12—"Bar reinforcement across transverse joint, without proper provision for slippage and clearance, resulted in breakage and subsequent expensive repairs.

13—"For long slabs, 75 to 100 feet or over, edge bar reinforcement with continuous bond caused corner cracks in the area of steel exceeded 1/4 sq. in.

14—"A remarkable agreement was found to exist between results of observations of roads in service and results furnished by a wide range of experimental roads and laboratory tests."

Effect on Strength of Concrete Hauled from Central Mixing Plant

It is frequently convenient to have a central mixing plant and haul the concrete ready mixed to the job. For example, it is often necessary to widen an existing road, which may be done effectively by the construction of concrete shoulders on each side. If a mixer were on such a job it would interfere much more with the maintenance of traffic than if no mixer were required. Particularly have central mixing plants been found useful in city pavement construction. The results of the tests of the cores drilled from concrete that was hauled varying distances is, therefore, of particular interest.

Under the charge of the State Roads Commission of Maryland a central mixing plant was set up at Muirkirk on the Baltimore-Washington Road to furnish the concrete for shoulders which extended four miles on each side of the road. Cores were drilled from these shoulders a year later and tested at the laboratory of the University of Maryland. These cores were drilled on each side of the road at one-quarter mile intervals, three cores being taken at each point. The results of the crushing strength of these cores showed a steady increase in strength as the distance hauled increased up to three miles, the average increase being from 3,000 pounds to a little over 4,000 pounds; the subsequent distance up to four miles showed a slight drop from the maximum, but gave strength tests decidedly greater than for the concrete that had not been hauled.

The conclusions reached from these results are that at least up to four miles haul the concrete did not suffer any decrease in strength, but rather showed an increase, and that so far as the strength of the concrete was concerned, four-mile hauls may be safely made. Thus it is a matter solely of practical and economical handling of the work whether the concrete would be hauled as great a distance as four miles.

Development of Curing Methods

Some attention has been paid recently to methods for curing, other than by application of wet earth to cover the roads, or by ponding. Due to the many instances where, because of dry weather or the remoteness of a sufficient supply of water, a practical method to cure a concrete road surface without use of water has become increasingly important.

The use of calcium chloride sprinkled upon the surface of the road has been tried. The admixture of calcium chloride in the concrete, also the surface treatment of the newly laid road with silicate of soda solution are still other methods. The latter particularly gives considerable promise of being effective and reasonably economical. A test was made during the summer and fall of 1926 by the State Roads Commission of Maryland in cooperation with the University of Maryland and the U. S. Bureau of Public Roads, using three methods of curing. The first method was to cover the concrete with moist earth in the customary manner; second, a surface treatment of silicate of soda diluted with 25 per cent water; third, an admixture to the concrete of sodium chloride, 100 pounds being dissolved in 42 gallons of water, which made approximately 50 gallons of the solution. Two quarts of this solution were added to the concrete for every bag of cement.

As the result of crushing strength tests of 30 and 90-day cores drilled from sections of the road cured in these various ways, it was noted that the surface treatment of silicate of soda gave somewhat greater crushing strengths than either of the other methods, thus indicating that concrete cured with the silicate of soda gave as good or better concrete than was produced by the other methods of curing. Whether the damp earth method or the silicate of soda method would be used in a given case would probably rest upon the relative cost.

Major H. D. Williar, Assistant Chief Engineer of the State Roads Commission of Maryland, reports that the earth road curing averaged 4.3c per square yard, the admixture of sodium chloride 5.1c and the silicate of soda a little over 3c. It was further noted by Major Williar that about 15 per cent of the road cured with the earth covering was somewhat cheapened because of the fact that due to cooler weather it was not necessary to cover it.

In connection with these tests, it is proper to note that there is a marked difference in the crushing strength of samples of concrete taken with cores drills, and cylinders of concrete cast in molds, even though the latter are filled with concrete from the same batch that goes into the road slab. Thus while the cylinders showed a breaking strength of perhaps 2,000 pounds, the cores would indicate in the neighborhood of 3,000 pounds per square inch crushing strength.

This is of interest in connection with the fact that recently in the City of Duluth fourteen blocks of concrete pavement, which it was decided to open to traffic as early as possible, were constructed of an expecially rich mixture 1:1½:2½, and the street opened to traffic as soon as cylinder molds from the concrete placed in the street reached a strength of 2,000 pounds per square inch, which I am informed was within four days. There is every reason to suppose that had cores been drilled from this pavement, the crushing strength would have been found to be considerably greater than that recorded for the molded cylinders.

Improvement in Methods of Finishing Concrete Roads

The hand finishing method by wooden trowels which was used in the building of earlier concrete roads left much to be desired as to quality of road surfaces. Striking templets, used with rollers and belts, were a great improvement over the hand finishing method, and led up to the development of road finishing machines. The machines most generally in use had a combined striking and tamping effect. But it was found that the result of the tamping action was to flush to the surface a layer of mortar which subsequently would scale in spots. To remedy this, these machines have been modified so as to eliminate the tamping effect, and in its place produce more nearly the result that is obtained by pushing over the surface a very heavy screed compressing the surface by squeezing it rather than by tamping. In fact, a concrete road surface that is finished by a heavy screed worked by hand, as was common in the early practice in Delaware and much used in the concrete roads in North Carolina, produces a very satisfactory surface.

Shoulder Construction Important

One of the most important features in construction and maintenance of concrete roads are the shoulders. It is generally agreed that the practice of stopping vehicles on the traveled way proper, especially of a two-lane road, causes great inconvenience to other travelers, and adds a very serious element of danger, both of which increases very rapidly with increase in the relative amount of traffic. It has been proposed that a traffic regulation should provide that for no reason whatsoever shall a vehicle be allowed to stand within ten to eleven feet of the center line of the traveled way. If such a regulation is to be practicable, it would be necessary to construct shoulders of sufficient width (five or six feet) for a vehicle to stand upon. The shoulders when adjacent to a two-lane width of not less than eighteen feet would not be expected to carry traffic, nor need there be constructed for this purpose, unless upon long grades exceeding 4 to 5 per cent, other than good sod shoulder, for when such shoulders are established they resist erosion remarkably well.

On steep grades in cuts, it will be necessary to modify the shoulder width. One of the best methods of construction under such circumstances is to carry the concrete for ten or twelve inches upon the slope, thus having the pavement itself form a gutter, the total available width being not less than twenty-four feet. This would permit a vehicle in an emergency to be parked at the side of the road, and still leave reasonable space for two lines of moving vehicles.

Core Drill Tests

It has been the practice in the past few years in a number of states for the State Highway Commission to take samples from concrete roads by drilling cores. Special core drilling apparatus has been used for this purpose, consisting essentially of a soft steel bit, the cutting being effected by small hardened steel shot. These core samples make it possible to examine the texture of the concrete, check the thickness, and obtain the crushing strength which affords some measure of the relative value of the different concretes.

The State Roads Commission of Maryland has taken several thousand core drill samples, this work being placed immediately under the charge of the Engineering College of the University of Maryland. An examination of the results has led to one very pertinent point. For example, a number of cores close by one another, presumably from the same mix of concrete, should theoretically give the same crushing strength. Practically, this is not the case. If we take the mean value of such a group and determine the percentage of variation of each individual of such a group from the mean value, we get values ranging from zero to perhaps 30 or 40 per cent. Such values were obtained for upwards of 1,600 cores, and it was found that the mean variation from these group means was about 8 per cent. An examination of crushing strengths of 6,000 concrete cylinders made in the laboratory under strictly controlled conditions showed a mean variation almost identical with that found for the cores drilled from the road.

Several hundred results of tests on steel specimens, however, gave a mean variation of less than 2 per cent, indicating that this value of the mean variation is indicative of certain definite characteristics of the materials tested. We may expect, therefore, to find a greater variation amongst the values from tests of concrete than from tests of steel. If in comparing results of concrete tests, for example to discover the effect of a different method of mixing or other variation in the method of making the concrete, if our results do not persistently show greater than 8 or 10 per cent difference, we cannot draw too nice conclusions as to cause and effect.

Elastic Properties of Concrete Determined by Tests

In the past few years there has been conducted at the University of Maryland a fairly extensive series of tests to measure the elastic properties of concrete. Such measurements had been made in the past, but from the nature of the apparatus used, the resulting stress strain diagrams were unsatisfactory in that they led to the wrong concept of the elastic curve of concrete, indicating that concrete even under comparatively low stress acted as a material having marked plastic properties, rather than elastic.

For the measurements made at the University of Maryland there was employed a simple arrangement of the mirror extensometer, so that much more accurate and delicate measurements were made possible. The essential fact that these measurements have established is that concrete up to a fairly definite limit acts essentially as elastic material in a manner similar to that which steel exhibits, and that beyond this limit it shows the characteristic stress strain curve for an elastic, plastic material, the limit of the straight line relation indicating the elastic limit which may be about as definitely located for concrete as for steel.

These tests show that the modulus of elasticity for concrete is for all practical purposes a constant up to certain definite stresses, and that there is no occasion for defining the modulus elasticity of concrete as that at a certain point on the stress strain curve as has been previously reported by some investigators. The fact that we may treat concrete as an elastic material, and subject concrete structures to analysis by the theory of elasticity is very handsomely confirmed by the results of measurements of the deflection of a concrete road slab under different loads as measured in connection with the Bates Road Tests, and other tests conducted by the Bureau of Public Roads at Arlington. The mathematical analysis of the action of a concrete road slab under elastic conditions is presented by Dr. Westergaard in the Proceedings of the Highway Research Board of 1925 and 1926.

Progress of Work Stimulated

Much attention has been given to factors that would influence the progress of work. Weather conditions that prevail in a large part of the United States make highway construction, of necessity, a seasonal occupation, but as the amount of work to be done has increased, highway engineers and contractors found it necessary to cooperate even more closely than in the past, to the end that everything possible be done to increase the output of finished roads. Thus, provision has been made for storage of materials for the winter months, with advance payments for the same; contracts have been let in the fall for the coming season's work, all of which has made it possible for contractors to maintain better organizations throughout the year, with a consequent saving of much time in the spring at the opening of the construction season. Whatever has been done to facilitate work has resulted in economy, not only to the contractor but to the public.

The development of road machinery has played a very large part in speeding up work. In fact, the labor situation has become such in the past few years that unless labor saving machinery had been devised, the work could not have been done. Thus, it has come about that on most concrete jobs but few men are employed who do not handle machinery of some character, reducing to a minimum the purely hand labor portion of the work. It is necessary only to visit the Chicago Road Show with its enormous collection of road-making machinery of all sorts to realize how great has been the labor saving devices that have been developed, and for the most part but recently developed.

Data as to the progress that has been made are of value to engineers and reference to these data will be made here. At present, the average yardage per contract for highway work is about 33,000 square yards. In 1926, one of the larger contracts was for 169,000 yards in North Carolina, and one was for 182,000 yards in Illinois. Data as to the records of laying concrete roads are found in the November, 1926, "Public Roads" magazine, where it is shown that a mixer turning out the possible maximum batches (48) 13 per cent of the time was for charging, 83 per cent for mixing, and 4 per cent for discharge. In the Engineering News-Record for June, 1924, page 1063, are to be found some very pertinent data as to the seasonal progress made by different crews on state highway work in Iowa. The record extends for over three years. The average number of feet laid per day was about 270. Pavement was laid on an average of about 70 per cent of the time.

In general, in the past few years a marked increase in the use of the larger mixers, the No. 28 and No. 32-E, is to be noted, although the 21-E size still remains the one most commonly used. One of the most complete studies of progress in concrete road construction is to be found in the series of articles by J. L. Harrison of the Bureau of Public Roads, beginning in the November, 1925, number of "Public Roads" magazine. This series should be studied by everyone interested in this phase of the question. The latest figures obtainable as to the amount of concrete pavement on our highways are the figures compiled by the Bureau of Public Roads up to 1926, which shows a total of 27,875 miles on the state highway systems and 10,106 not on state highway systems, a total of 37,981 miles.

First Central States Safety Congress To Meet at Kansas City

When the First Annual Central States Safety Congress convenes at Kansas City April 13, industrialists from the fifteen commonwealths between the Rockies and the Mississippi will have their first chance to get together and discuss common problems. This meeting is sponsored by the National and Kansas City Safety Councils and various regional bodies and also includes public, home and school safety sessions. Opening with a general session April 13, there follows an industrial general session, at which these subjects will be presented: "Organizing the Plant for Safety," "Every Foreman a Safety Director," and "Keeping the Safety Committee Alive."

The Cement section of the National Safety Council will be represented by a large delegation, and a special session for this group has been arranged April 14. W. S. Sabin, Portland Cement Association, will preside. H. G. Burgess, Kansas City Public Service Company, Kansas City, Missouri, is to tell "How to Keep Men Interested in Their Own Safety." "Getting Men to Report for First Aid" is the subject of a speech by Harold R. Williams, Ash Grove Lime and Portland Cement Company, Kansas City, Missouri. Henry A. Reninger, Lehigh Portland Cement Company, Allentown, Pennsylvania, speaking on "Fixing Accident Responsibility," will conclude the session.

Manufacture of Wall Covering Has Increased Rapidly

The department of commerce announces that, according to data collected at the biennial census of manufacturers taken in 1926, the establishments engaged primarily in the manufacture of wall plaster, wall board and floor composition reported for 1925 a total output valued at $90,957,045, an increase of 23.2 per cent as compared with $73,800,539 for 1923, the last preceding census. The principal products of this industry are gypsum plaster and other ready mixed plasters and similar preparations, such as hard wall plaster, plaster wainscoting, fiber plaster, stucco, calcined plaster, molding plaster, plaster board, asphalt mastic and ornamental plasterwork for interior decoration, gypsum and other wall boards and floor composition.

In addition, wall plaster, wall board and floor composition were manufactured to some extent by establishments engaged primarily in other industries. The value of such commodities thus produced outside the industry proper in 1923 was $4,407,830, an amount equal to 6 per cent of the total value of products reported for the industry as classified. The corresponding figures for 1925 have not yet been calculated, but will be included in the final report of the present census. Of the 222 establishments reporting for 1925, 33 were located in California, 15 in Illinois, 11 in Iowa, 4 in Kansas, 14 in Michigan, 4 in Nevada, 8 in New Jersey, 41 in New York, 17 in Ohio, 10 in Pennsylvania, 5 in Texas, 5 in Washington and the remaining 55 in 24 other states.

Highway Construction In Panama Progressing Satisfactorily

Highway construction in Panama is progressing satisfactorily according to information obtained from the Central Roads Board. Work was resumed about January 1, and it is expected by the end of the present dry season (May 1st) to have completed the grading and bridge work and all the surfacing excepting on a short section immediately adjoining the Canal Zone, which is expected to be done by the United States Government. In order that this road section, consisting of 329 kilometers (practically all macadam highway), in the provinces of Panama, Cocle, Los Santos, Herrera and Veraguas, may be connected with the capital, there remains to be built the road from the western boundary of the Canal Zone to its intersection with the completed highway of the Zone extending into Panama City. The commander in chief of the National Police has been ordered by the Executive to establish a road patrol for the purpose of preventing violations of traffic regulations.

SOURCES OF DUST IN COAL MINES

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PART I

THE data contained in this paper was collected during the course of an investigation which covered 15 representative coal mines in 6 coal-mining States. The purpose of the investigation was to determine by atmospheric sampling how much dust was raised into the air during the various operations of coal mining, such as undercutting with machines, loading coal by hand, and transporting it from the working face to the surface. The data thus obtained were considered from two angles—namely, the possible physiological effect of inhalation and the explosion hazard of the dust. No attempt will be made to discuss the former factor in this paper.

Conditions of Mining

The mines in which this investigation was conducted were considered representative, and it is believed that the results obtained will suffice for the average dustiness encountered in most coal mines. All of the coal mined was bituminous, from beds 30 to 120 inches thick. Only the ordinary room-and-pillar system of mining was employed. Daily production ranged from approximately 700 to 1,500 tons and the men employed from 150 to 450. Coal was undercut by short-wall mining machines in all mines, with the exception of one in which pick mining was employed. Loading at the face was done by miners; none of the mines used mechanical loaders. Electric drills, both for brushing roof and for shooting coal, were commonly used, although some roof work was done with jack-hammers and a little of both with augers. Coal was hauled by motor, mule, or rope power in end-gate cars with capacities ranging from 1,800 to 3,600 pounds. With few exceptions, coal was won at the face by dry methods—that is to say, no water was employed for wetting down the dust either during undercutting, loading, or transportation.

The common sources of coal dust as observed, arranged by decreasing amounts, were as follows: Undercutting with mining machines; loading coal at face of workings; and transportation of coal. The dust raised into the air at the face during undercutting varied from light to very dense clouds which made visibility poor. Very light to comparatively dense clouds of dust were raised during loading. In all instances the air was clear to vision during the transportation of coal.

Collection of Dust Samples

All dust samples were collected to be as nearly representative as possible of the dust-producing operations, such as undercutting across a 10, 20, 30, or 40-foot face, completely loading cars by one or two workers, and transporting coal in rapid or slow-moving trips. For undercutting, the collection was commenced before sumping operations, and was continued until the entire face was undercut. Samples were taken in development entries and along main haulage-ways, where mules, motors, or ropes were used. None were taken in pillar workings. In order to get the average dustiness throughout the day, dust sampling was done before men started to work, and throughout the working shift at intervals of one-half to one hour. These were supplemented by atmospheric dusts taken at representative places throughout the mine.

The sampling outfit used in this investigation was the impinger. This instrument consists of a small portable hand-cranked suction pump connected by means of a flexible rubber tube to an 8-ounce wide-mouth bottle containing a rubber stopper bearing two ½-inch glass tubes, one of which is the attachment to the suction pump and the other to the inlet for the dust-laden air. The latter is the impinger proper; it consists of a glass tube drawn down sharply at one end to a small orifice and supporting a brass plate 5 mm. from the opening, and the whole is immersed as deeply as possible in 150 centimeters of suitable liquid, water usually. The pump and bottle are both supported on a collapsible metal stand at a comfortable working height.

Composition of Dust Samples

The composition of the dust, as determined by petrographic examination, varied with the material handled. Mechanical drilling was done in sandstone, shale, and slate roof. Dust samples collected during these operations showed little or no coal. Auger drilling by hand was performed in both roof and coal, and the composition of the dust raised consequently corresponded to the material drilled. Mining machines occasionally dug into the floor, but more than 99 per cent of the dust raised during undercutting was coal. Bony partings shot down with the coal occasionally contaminated the dust produced during loading, but 99 per cent of this material was coal dust. Along the haulageways the composition of the dust varied. In non-rock-dusted entries, the suspended particles were almost entirely coal but in rock-dusted places some of the atmospheric dust was of the same material as that used for rock-dusting.

Table 1 gives by count and weight and in order

Presented at the meeting of the American Institute of Mining and Metallurgical Engineers, New York City, February 14-17, 1927.

Table 1—Summary of Dustiness by Operations

Operation	No. of Samples	Kind of Material	Millions of dust particles per cubic meter[a] of air. +10 microns	—10 microns	Total	Milligrams[b] of dust particles per cubic meter of air. +10 microns	—10 microns	Total
Drilling:								
Jackhammer	6	Sand Shale	1881	130,138	132,020	1753.0	1045.0	2799.0
Electric	4	Shale	318	15,347	15,665	....	....	192.3
Undercutting coal,								
Dry methods:	42	Coal	245	9,565	9,810	254.6	103.9	358.5
Narrow work	11	Coal	168	11,890	12,058	325.3	146.9	472.2
Wide work	31	Coal	273	8,740	9,013	229.5	88.7	318.2
Auger drilling by hand	5	Coal Shale	25	1,959	1,984	29.8	16.3	46.1
Loading coal	40	Coal	41	1,500	1,541	66.6	28.1	94.7
Undercutting coal, wet methods:	3	Coal	35	1,367	1,402	24.5	25.9	50.4
Tipple	4	Coal	18	1,159	1,177	23.8	7.9	31.7
Pick mining and loading coal	10	Coal	42	615	657	24.4	14.8	39.2
Loading rock	2	Sand Shale	6	291	297	6.6	1.7	8.3
Haulage:	70	Coal	4	248	252	3.9	3.6	7.5
Mule	11	Coal	7	609	616	7.3	3.9	11.2
Motor	35	Coal	5	202	207	4.2	5.2	9.4
Rope	24	Coal	2	151	153	1.9	1.0	2.9
Pick mining coal	6	Coal	20	148	168	16.0	5.7	21.7

a 1 cubic meter = 35.314 cubic feet. *b* 1 milligram = about $\frac{1}{28,000}$ ounce avoirdupois.

micron = about $\frac{1}{25,000}$ inch. Throughout the paper +10 refers to particles more than 10 microns in diameter, and —10 to the particles below this limit.

of decreasing magnitude of total counts, the amount of dust raised per unit of volume of air during mining operations and includes jackhammer drilling, undercutting coal in wide and narrow work, under both dry and wet conditions, drilling with electric drills and hand augers, loading coal at working face, picking at face and transportation of coal by mule, motor or rope haulage. In addition the table gives the amount of dust raised at the tipple after the coal has reached the surface.

Discussion of Data

In connection with dust weights and counts in this report it is important to keep in mind that all the —10 micron dust, also probably all of nearly all of the +10 micron dust, in the tabulations in the report is of size which would very readily enter into an explosion. It will be noted that the most dust per unit of volume was raised by jackhammer drilling in roof; the average count of 6 samples from drilling at an angle of 10 to 15 degrees up was 132,020 million dust particles per cubic meter of air. Electric drilling in either coal or roof ranked second in order of dustiness. Four samples taken from drilling at an angle of 10 to 15 degrees up in roof gave 15,665 million dust particles per cubic meter air.

Dry undercutting in coal ranked third in order of dustiness, 42 samples, 11 being from narrow work (places under 12 feet wide) and 31 from wide work (places over 12 feet wide), averaged 9,810 million particles per cubic meter. The 11 samples, representing 118 feet of cutting in narrow places showed an average dustiness of 12,058 million, and the 31 samples from 840 feet of wide work an average of 9,013 million. The fourth dustiest operation namely, hand auger drills, operated in positions varying from horizontal to vertical showed 1,984 million particles. Loading at face was the fifth in order of dustiness; 40 samples raised an average of 1,541 million. Undercutting in coal using water on the cutter bar was sixth in total amount of dust, the three samples averaged showing 1,402 million particles per cubic meter air.

Pick mining and loading simultaneously was seventh in dust magnitude and showed an average of 657 million particles for 10 samples. Loading rock averaged 297 million for two samples; these were gathered in mines where much brushing was necessary to provide adequate height for haulage. Transportation of coal from working face to tipple showed the least amount of dust of all mine operations except pick mining. Haulage by mule, motor, or rope averaged 616,207, and 153 million dust particles, respectively, and 252 million for the operation as a whole. Pick mining at the face showed the least amount of dust raised for any of the regular mining processes; the average for 6 such samples was 168 million. The four samples taken around the tipple showed a large amount of dust raised by surface work, 1,177 million particles for the four samples gathered. The weight of dust particles ranged in decreasing amounts from 2,799 milligrams per cubic meter air for jackhammer drilling to 7.5 milligrams for haulage. The average weight for hand undercutting in wide and narrow work was 358.5 and for loading coal, 94.7. The operations with high counts of dust almost always showed correspondingly high weights and those with low counts showed low weights.

The above order of dustiness held in almost every individual mine, although the magnitude of the figures varied.

Dust Produced by Mechanical Drilling

Table 2 shows, by mines, the dustiness during mechanical drilling with either jackhammer or electric drills.

Table 2—Dustiness by mines during drilling

Mine	No. of Samples	Millions of dust particles per cubic meter of air			Milligrams of dust particles per cubic meter of air		
		+10	—10	Total	+10	—10	Total
			Jackhammer				
A	4	2,642	182,349	184,993	2,478	1,497	3,976
L	2	359	25,715	26,075	305	141	444
			Electric Drill				
C	3	391	17,803	18,194	...	...	230.7
D	1	100	7,979	8,079	44.1	33.1	77.2

Discussion of Data

There was a wide range in the dustiness from jackhammer and electric drilling in different mines. Four samples collected in one mine while a jackhammer was drilling in sandstone, shale, and slate roof in turn, at an angle about 10 degrees up, the cutting dropping 3½ to 5 feet in almost still air, show an average count of 184,993 million particles; whereas, in another mine where two samples were taken after jackhammer drilling in relatively soft shale and sandstone under similar conditions, only 26,075 million particles were raised. Similarly, in a mine where three samples were taken while electric drills were working at angles of 10 to 15 degrees up, the cuttings falling 3½ to 4 feet in almost still air, 18,194 million particles were raised; and in another mine where only one sample was taken, under similar conditions, 8,079 million were produced. The weight of dust in milligrams per cubic meter air for jackhammer drilling is very much greater than the weight for electric drilling. In each instance the weight parallels the dust count.

The wide range in dustiness in different mines during jackhammer drilling, and similarly for electric drilling, can be accounted for by the different nature of the material drilled, condition of the machines used, continuity of the operation, depth of hole, angle of drilling, distance through which cuttings fall, and air movement at points of sampling. The difference in weights of dust between the two methods of drilling is due to the difference in the two types of drills. It must be borne in mind, however, that while the amount of dust per unit volume of air raised by these operations is excessive, nevertheless, the total amount so raised is small because of the infrequency of such work. The physiological effect would be largely on the few men required to run these machines.

The dust produced by these activities contained very little coal. As all of this drilling was in rock roof, it was only as thin lenses of coal were struck that anything other than siliceous dust was raised. The composition of the atmospheric dust followed very closely the composition of the rock drilled.

Dust Produced by Undercutting Dry

Table 3 shows the dustiness of mine air while coal was being undercut dry, and the number of samples averaged to give each figure, and represents the average dustiness per unit of volume of the working places at each of the mines during this one operation.

Table 3—Dustiness by mines when undercutting dry

Mine	No. of Samples	Milligrams of dust particles per cubic meter of air			Milligrams of dust particles per cubic meter of air		
		+10	—10	Total	+10	—10	Total
F	6	977	25,564	26,541	560.2	192.6	752.8
M	11	178	16,812	16,990	505.5	213.4	718.9
D	5	88	4,537	4,625	93.8	88.3	182.1
E	2	474	2,724	3,198	119.5	83.5	208.0
K	7	73	2,213	2,286	89.2	33.2	122.4
L	9	56	1,974	2,030	35.8	26.0	61.8
H	2	35	1,020	1,055	58.8	18.3	77.1

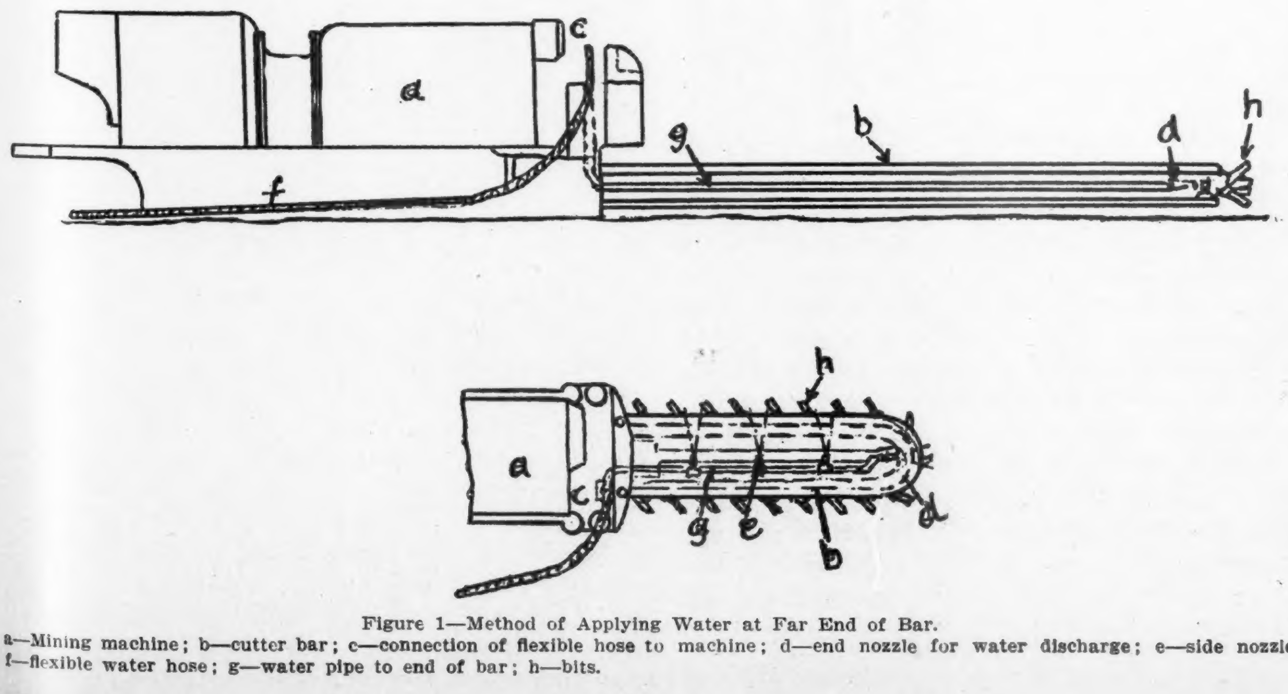


Figure 1—Method of Applying Water at Far End of Bar.
a—Mining machine; b—cutter bar; c—connection of flexible hose to machine; d—end nozzle for water discharge; e—side nozzles; f—flexible water hose; g—water pipe to end of bar; h—bits.

Discussion of Data

It will be noted that there was a wide variation in these figures in different mines, ranging from 26,541 to 1,055 million particles weighing from 752.8 to 61.8 milligrams per cubic meter. More significant than the actual size of the figure is the fact that in each mine where averages were arranged by operations in order of magnitude, the figures for undercutting were greatest excepting only dust raised by mechanical drilling. As drilling affects much less material than undercutting, the total amount of dust raised by undercutting is considerably greater than that produced by drilling.

The chief factors that entered into this wide range of results in different mines were: Character of coal, experience of operatives, condition of equipment, moisture conditions in working places (all of which affect the total dust produced), and circulation of air at or near working faces (which controls the dilution of the dust). Friable coal, inexperienced operatives, dull bits on mining machines, and dry working places tend to increase dust; while hard coal, experienced machine men, sharp bits on machines, and damp working places tend to reduce dust. Poor circulation of air at the face means an increase in the amount of dust in each unit of volume of air; good circulation of air in working place dilutes and removes the dust as it is produced, and so lowers the figures.

Dust Produced by Hand Drilling

Table 4 gives details of dustiness in mines using hand auger drills. The drilling was in shale roof 3½ to 5 feet above the floor, and in coal face about 2 feet from the floor.

Table 4.—Dustiness by mines when drilling with hand auger.

Mine	No. of Samples	Positions of holes*	Millions dust particles per cubic meter of air			Milligrams dust particles per cubic meter of air		
			+10	—10	Total	+10	—10	Total
F	1	80 degrees	75	3,937	4,012	68.3	40.7	109.0
K	1	90 degrees	12	2,961	2,973	30.6	15.4	46.0
L	2	15 degrees	15	1,404	1,419	22.4	8.5	30.9
O	1	0 degrees	8	89	97	5.7	8.3	14.0

*Position with reference to the horizontal.

Discussion of Data

These results show a comparatively high range in amount of dust encountered but the least dust of any of the drilling operations studied. In the three mines showing the largest amount of dust, drilling was in shale roof which afforded opportunity for the dust to scatter and be distributed by the ventilating current in falling. In two of these mines drilling was being done nearly vertically. These samples show the maximum dust conditions. The smallest amount of dust was raised while drilling horizontally in coal at the face. Hand auger drilling is a decidedly slower process than mechanical drilling; consequently there is better opportunity for air currents to remove the dust while it falls from the hole to the floor. This undoubtedly is why the operation produces much less dust than either of the mechanical methods. The variation between individual samples and mines can be easily explained by the kind of material drilled, the angle and depth of drilling, distance through which cuttings fall, condition of drill, continuity of operation, and air movement at the point of sampling.

Dust Produced When Loading Coal

Table 5 shows the results of sampling when coal was being loaded:

Table 5—Dustiness by mines when loading coal.

Mine	No. of Samples	Millions of dust particles per cubic meter			Milligrams of dust particles per cubic meter		
		+10	—10	Total	+10	—10	Total
M	10	47	2,758	2,805	107.7	52.7	160.4
K	10	63	2,032	2,095	96.4	37.2	133.6
D	2	67	1,373	1,440	93.6	41.1	134.7
F	7	25	1,130	1,155	35.6	12.8	48.4
O	3	66	406	472	51.8	24.0	75.8
H	2	16	455	471	18.0	0.6	18.6
L	6	7	224	231	10.0	0.8	10.8

Discussion of Data

It will be noted that there was a wide range of dustiness during loading operations, varying from 2,805 to 231 million dust particles per cubic meter air and from 160.4 to 10.8 milligrams. The size of coal loaded ranged anywhere from large lumps to machine cuttings; the number of loaders from 1 to 3, averaging two loaders per car; and the number of cars loaded from 1 to 4, averaging about one to two cars per sample collected. In all mines, with the possible exception of the mine in which pick work was employed, the size of coal, generally speaking, was ordinary run-of-mine. Where pick mining was used, large lumps, half the size of a man in many instances, were cut out of the solid and lifted into the car. In this mine, minimum dust conditions during loading were encountered. The worst condition in loading was found while "bug dust" was being loaded. One such sample showed 10,134 million particles, weighing 677.3 milligrams, while the average of 5 similar samples was 3,510 million particles, weighing 246.1 milligrams per cubic meter of air, amounts to more than twice the average of the loading operation as a whole.

The principal factors affecting the concentration of dust raised during loading can be summarized as follows: Size of coal, number of coal loaders, number of cars loaded, character of coal loaded, method of winning coal at face, moisture conditions, air movement at working face, activity of the men, and number of times coal is handled. Fine coal, of a friable nature, tends to form more dust than harder material, while the more men working, the more cars loaded, the faster the work, the more times the coal is handled between face and car the more dust will be stirred up. Dry coal will tend to increase the amount of dust in the air and lack of ventilation will allow dust to accumulate in the surrounding air.

(Second Part of this Article will appear in the next issue)

WHY PROFESSOR GEORGE F. SWAIN PREFERS STEEL TO REINFORCED CONCRETE

THE principal materials used in structures are wood, stone, burnt clay products, concrete and reinforced concrete, and steel. Each of these is valuable, and appropriate under certain conditions. It is the purpose of this paper to compare these materials, but mainly to compare reinforced concrete with steel and iron, and to give the reasons for my convictions that reinforced concrete has been over-boomed with the result that it has been and is being used in many cases where steel is decidedly preferable.

What are the desirable characteristics of a structural material? It depends to a large extent upon the purpose and use, and the kind of stress to which it is exposed, but the following characteristics will be admitted to be generally desirable: Economy; Durability; Strength; Elasticity; Resilience; and Toughness. Another desirable property is that of usability at all times and seasons, independent of weather. Still another is constancy, another is absence of initial stresses and finally one of the necessary qualities is reliability, or freedom from risk if proper care is taken.

How does reinforced concrete compare with steel? First, let us consider certain qualities of steel and of reinforced concrete. Steel is a finished product, the result of years of experience, experiment and study. It has, in higher degree than any other material, all the desirable qualities that have been named. It is exceedingly strong, durable if properly taken care of, elastic, resilient, tough, with great tensile strength, usable at all times, unchanging, and reliable. The chemical composition and the physical properties can be accurately controlled.

Steel does not change after it is put into a structure. It does not crystallize under repeated loads. It is subject, as all materials are, to expansion and contraction due to change of temperature, but, if statistically determined, these need not cause stresses, and, if not, they may be computed.

As compared with these qualities of steel, the first peculiarity of concrete to be noted is that it is not a finished product. It is made on the job. The constituents—stone, sand, cement and water, are each subject to defects that must be guarded against, and they are extremely variable.

But another most important characteristic of concrete is that it changes after it is placed beyond recall in the structure. In this respect it differs radically from all other structurel materials. The real manufacture of the material begins, then, when it begins to set and harden. All concrete, unless waterproofed, is more or less porous, and will swell and shrink when wetted and dried, and with varying moisture in the atmosphere.

Consider the situation for a moment. Concrete is a material made on the job, dependent upon the quality of stone, sand, cement and water, the proportions, the care in mixing and placing, and much influenced by small variations in the quantity of water used. Its ultimate condition depends much upon the curing, or treatment during setting, and the amount of water given it. It expands and contracts subsequently as it is wetted and dried. Is it not obvious that there must be considerable uncertainty in the resulting product?

The strength of concrete varies with the temperature and with the degree of saturation. According to Prof. A. B. McDaniel the compressive strength of 1:2:4 concrete at 28 days varies from about 1,520 lbs. per square inch when kept at 90 degrees F. to less than 500 lbs. when kept at 15 degrees F. He says that concrete one week old maintained at a temperature of 60 to 70 degrees will have practically double the strength of the same material if kept at 32 to 40 degrees.

But this is not all. Setting in water, reinforced concrete expands, causing tension in the steel and compression in the concrete. Professor White says that "these volume changes, which seem due to a fundamental property of portland cement, are the most potent causes of the destruction of concrete exposed to the weather. If concrete is to be kept constant in volume, its moisture content must be held relatively constant."

The expansion of 1:2:4 concrete in water may amount to 0.01 per cent in 120 days, and the contraction in air to 0.05 per cent or more. This means that a bar 100 feet long may contract 0.6 inch. If this bar is reinforced, the contraction will be less because the steel will resist it. If the modulus of elasticity of concrete is 2,000,000, and the percentage of reinforcement 0.5, the compression in the steel, of all parts of the length contract alike, would be about 14,000 lbs. per sq. inch, and the average tension in the concrete about 75 lbs. per square inch. If the modulus of elasticity of the concrete is 3,500,000, as it may be when fully hardened, the stresses will be larger. The tension in the concrete will not be uniform over the whole section, but will be greatest at the rod, where it will much exceed the average, while at the edges it will be less. Also, in a bar shrinking, the maximum stresses will be at the center of the length and the maximum bond stress at the ends, and the maximum stress may be 50 per cent greater than stated.

Consider now the concrete column reinforced by longitudinal rods. The shrinking of the concrete

Editor's Note: This article is a summary of what Professor Swain had to say before the Boston Society of Engineers on December 15, 1926.

due to varying moisture will, as we have seen; produce initial compression in the rods, which may be large. Now the slender rods, if standing alone and subject to the loads that they are assumed to carry, would bend laterally. They would not carry these loads. They are only prevented from bending by the surrounding concrete. But they tend to bend all the time, and so tend to split off the surrounding concrete unless all the rods tend to bend toward the center of the column, which cannot be assumed. Here, then, we have a compound material in which one material tends, by its own action, to make the other fail, and does make the other fail, at the ultimate load.

Concrete is subject to corrosion and dissolving out of the cement; is comparatively weak against all kinds of stress, and especially tension; is not elastic, but takes a set at small loads; is much less resilient than steel; is therefore lacking in toughness; requires special precautions if it is to be used in cold weather; changes after it is in the structure; expands and contracts when wetted and dried, with resulting stresses which may be serious; and is much less reliable than steel.

Summarizing, Prof. Swain said that he would rather use burnt clay products than concrete for many purposes, as for roofing tiles and for drains and sewers, and in many cases for walls and as hollow blocks for floors. For a structure which can be made of steel so as to be accessible for inspection and painting, he would much prefer steel to reinforced concrete. This includes railway and highway bridges, tanks and standpipes, stadiums and grandstands, ships and barges, cars, etc.

How is it about structures like buildings, in which, if of steel, the metal is not everywhere accessible? Well, in such a case it is undeniable that steel is just as accessible as the reinforced rods in reinforced concrete; in fact, more so. Therefore he would prefer steel for building, adding that he would much rather have a steel frame building than a concrete building, especially if subject to earthquakes or hurricanes.

He then quoted Professor Alvarez of the University of California in a report on the Santa Barbara earthquake, published by the Portland Cement Association which says: "The well riveted and strong but flexibly braced structural steel frame, fireprpofed with good concrete properly held in place, is the safest frame of all. A frame of this character has never collapsed in an earthquake."

Prof. Swain said that he entirely endorsed this, and it did not need an earthquake to prove it. However, he would rather have a steel column than a reinforced concrete column; a steel girder, protected by concrete or gunite, or hunched in concrete, than a reinforced concrete girder. He would rather have a column footing of steel beams than of reinforced concrete. Adding that he would put his reliance in every case on the steel, which can be tested and examined in its finished state before using, and which does not change its constitution after using. He also believed that a steel arch may be made just as beautiful as a concrete arch; and, anyway, what is beauty compared to reliability and security?

Natural Resources of Pikes Peak Region Varied in Nature

The natural resources of the region include Sawatch sandstone, Dakota sandstone, shale gypsum, coal, fire clay, rhyolite, colored clay, and lumber in commercial quantities. Sawatch and Dakota sandstone are found in the vicinity of Colorado Springs. Both are very good building stones and greatly in demand. Volcanic dykes composed of felsitic lava occur northwest of the city.

Deposits of a very fine conglomerate occur just east of Colorado Springs which is a very beautiful and substantial stone for ornamental foundations, fences, etc. Overlying the Sawatch sandstone is a very large deposit of ordovician limestone suitable for the manufacture of hydrated lime.

All the deposits necessary for the manufacture of portland cement are found in large quantities a distance of only six miles from Colorado Springs. These deposits include high grade limestone, calcareous, shale and gypsum. This gypsum is also very valuable in the manufacture of land plaster and plaster board. This region contains an unlimited deposit of sub-bituminous coal. There is a considerable coal bearing area lying east of the city which as yet is undeveloped. Fire clay deposits occur north and east of the city and are as yet practically untouched.

A deposit of cryolite occurs southwest of the city which is valuable for the manufacture of glass products. About 20 miles southeast of the city is a formation called "painted hills" which contains clay deposits of many colors, which are of value in the manufacture of paint and calcimine. A considerable supply of western yellow pine exists in the Woodland and Manitou parks, near Colorado Springs, easily accessible. This same pine lumber is found in the Black Forest region, about 20 miles northeast of the city. This, however, is of small dimensions and is especially adapted to the manufacture of box lumber, the quantity being sufficient for constant operation, on a considerable scale.

Plastic Compositions

A composition to be molded under pressure is obtained by finely grinding volcanic rock or lava, grading the material, and stirring into it a solution of sodium silicate. The molded articles may be baked at temperatures of 800-900 degrees C., or they may be enameled. Michelin et Cie. (British Patent 263,138).

LIME ASSUMES IMPORTANT POSITION AT CHEMICAL SOCIETY MEETING

THE application of science and engineering in the lime industry with a resultant improvement in products and increased efficiencies in production, will be one of the feature discussions of the Lime Symposium which will be held by the Industrial Division at the Richmond meeting of the American Chemical Society, April 12-16.

Proper kiln design and operation for increased efficiencies will be discussed by V. J. Azbe, consulting combustion engineer, who has redesigned and operated kilns at lime plants in various sections of the country and has studied the effects of different conditions of burning on the properties of widely differing stones. Tests of the effects of injection of steam in kilns will be described by E. E. Berger of the New Brunswick Station of the Bureau of Mines, and a comparison of shaft and rotary kilns will be presented by R. K. Meade, consulting engineer of Baltimore.

The results of an extensive series of tests conducted to develop an economical and durable heat resistant water paint or whitewash will be contained in the paper by E. P. Arthur, formerly of the staff of Ohio State University. At various points in practically all industrial plants there is a need for surface coatings which will withstand temperatures above those which destroy ordinary oil plants. Large numbers of such coatings have been recommended but objections may be found to most of these on the basis of cost, either of application, light effects or durability.

The refractory properties of lime and the whiteness of films obtainable with whitewashes led to a study of the possibilities of adapting such coatings for use on surfaces subject to high temperatures. Very satisfactory results have been obtained and formulas have been developed which produce films that are standing up after several months exposure under very severe conditions. The fields for application of these high temperature whitewashes are numerous and the details of these investigations will be of direct interest to all industrial chemists.

Another interesting commercial application of X-rays is that of the study of limes and limestones, a development which will be described by Miss Marie Farnsworth of New York University during the meetings. It is a common experience that two limestones from different sources but having approximately the same composition will yield limes of totally different physical characteristics and that other stones of widely differing composition may yield limes of very similar properties. Some hydrated lime, for example, when made into a putty will spread quite smoothly and without pull under the trowel while others of the same composition work tough and harsh. Miss Farnsworth will describe the use of X-rays in the study of commercial limes and stones and will offer an explanation of some of these differences.

The relation of science and the scientific investigator to the industry as viewed from the point of view of the manufacturer will be discussed by Charles Warner, president of the Charles Warner Company and of the National Lime Association. Mr. Warner is active in promoting the idea of cooperation within an industry for the purpose of solving technical problems in which individual companies are mutually concerned and in developing close collaboration between producer and consumer for the benefit of both.

Oliver Bowles, superintendent of the Non-Metallic Minerals Experiment Station, U. S. Bureau of Mines, will outline the present progress and future tendencies in the industry, and Professor R. T. Haslam of Massachusetts Institute of Technology will discuss the general research problems presented in the major processes, such as the calcination of the stone and the hydration of the quicklime. No industry presents more attractive problems for scientific investigation than does this industry, which until the last few years has been neglected by the scientist.

The relation between research and profits will be discussed, also from the viewpoint of the manufacturer, by W. E. Carson, president of the Riverton Lime Company. Mr. Carson is one of the pioneers in the field of lime technology and one to whom the present scientific progress of the industry is largely due. Representatives of a large number of the various chemical industries using lime will describe investigations of the specific problems connected with its use in their processes, and Prof. J. R. Withrow, Ohio State University, will summarize the problems and needs of the industry.

A discussion of the problems involved in causticizing will also be included in the Symposium on Lime. The causticizing of soda ash with lime to produce caustic soda is of importance not alone in the production of caustic as such but also as an intermediate process in the paper, soap, and other industries. The tonnage of lime consumed is greater than in any other process. A paper on the subject of limes used and some variables affecting their behavior will be presented by J. V. M. Dorr, president, and Dr. A. W. Bull, research chemist of the Dorr Company. This company for some time has been studying conditions, particularly in pulp mills, which affect causticizing rates, settling rates of sludges, lime and soda efficiencies, etc., and their data and conclusions will be given in detail. The adaptation of equipment to meet mill conditions and the characteristics of the limes available will also be discussed.

Lime is used by 115 industries in their processes and this fact, together with the advance in scientific knowledge of the material and its properties, has stimulated interest of the Society members to such a point that the projected Symposium bids fair to be one of the outstanding features of the meeting. During 1926, the last figures available, there were produced approximately 5,000,000 tons of lime with a value of $46,500,000, of which about 45 per cent was consumed by the chemical industries, not including the large tonnage consumed by those industries which produce their own lime.

The Symposium will be held all day April 13 and the morning of April 14. The subjects and speakers for both days are:

APRIL 13, 9:30 A. M.

I. Introduction

9:30 A.M.—"The Problem of the Lime Industry," James R. Withrow, Chairman.

II. General Bearing of Lime Problems

9:45 A.M.—"The Consumer—The Market—The Lime Business and the Chemical Industry," Charles Warner, President, National Lime Association and of Charles Warner Co., Wilmington, Del.

10:10 A.M.—"Present Progress and Future Tendencies in the Lime Industry," Oliver Bowles, Superintendent Non-Metallic Minerals Experiment Station, U. S. Bureau of Mines, New Brunswick, N. J.

10:30 A.M.—"General Research Problems of the Lime Industry," Prof. R. T. Haslam, Massachusetts Institute of Technology.

10:50 A.M.—"Bridging the Gap Between Research and Profits in the Lime Industry," W. E. Carson, President Riverton Lime Co., Riverton, Va.

11:15 A.M.—"Limes Used in Causticizing and Some Variables Affecting Their Behavior," J. V. N. Dorr, President, and A. W. Bull, Research Chemist, The Dorr Co., 247 Park Ave., New York.

III. Problems of Specific Lime Uses

11:40 A.M.—"The Composition of Commercial Limes and Their Specification for Industries," J. M. Porter and J. S. Rogers, U. S. Bureau of Standards, Washington, D. C.

12:00 A.M.—"The Lime Problem of Agriculture," J. A. Slipher, Ohio State University, Columbus, Ohio.

2:00 P. M.

2:00 P.M.—"Lime Problems in the Softening and Sterilization of Water," C. P. Hoover, Chemist in Charge, City Purification Works, Columbus, Ohio.

2:25 P.M.—"The Uses of Lime in Butter Making," Prof. O. R. Overman, University of Illinois, Urbana, Ill.

2:45 P.M.—"Importance of the Proper Lime in the Use of Liquid Chlorine for Bleaching and Sterilization," A. H. Hooker, Hooker Electrochemical Company, Niagara Falls, N. Y.

3:10 P.M.—"The Use of Lime in the Paper Industry," P. A. Paulson, Kimberly-Clark Paper Co., Appleton, Wis.

3:30 P.M.—"Lime Problems in the Beet Sugar Industry," Ralph Shafor, Great Western Sugar Co., Denver, Colo.

3:50 P.M.—"The Role of Lime in Tanning," George D. McLaughlin, University of Cincinnati.

APRIL 14, 9:30 A. M.

IV. Research, Development and Engineering in the Lime Industry

9:30 A.M.—"The Effect of Particle Size on the Hydration of Lime," Fred W. Adams, Field Station, M. I. T., South Brewer, Me.

9:50 A.M.—"High Temperature Whitewash," E. P. Arthur, Parkersburg, W. Va., and James R. Withrow.

10:10 A.M.—"Economies Through the Use of Lime in Open Hearth Practice," C. H. Herty, Jr., Bureau of Mines, Pittsburgh, Pa.

10:40 A.M.—"A Brief Analysis of the Function of Steam in the Lime Kiln," E. E. Berger, New Brunswick Station, U. S. Bureau of Mines.

11:00 A.M.—"Rotary Kilns vs. Shaft Kilns for Lime Burning," R. K. Meade.

11:30 A.M.—"The Science and Engineering of Lime Burning," V. J. Azbe, 6625 Delmar Boulevard, St. Louis, Mo.

V. Summary

12:00 Noon—"Summation of Needs and Future of Lime in the Chemical Industry," James R. Withrow, chairman.

Lorain Yard Shovel

The Thew Shovel Company has issued a folder describing the Lorain 60, one yard shovel, crane and dragline machine. This machine has been designed and is being manufactured for plants who do not immediately require 1¼ yard capacity and is claimed to offer advantages new to shovel manufacture. It is claimed that in the past, when the demand for one yard machine became pressing, attempts were made to meet this demand by stepping a ½ or ¾ yard machine up to 1 yard capacity. However the Loraine 60 is different, it has been stepped down to one yard capacity. It is the Lorain 75 in everything but dipper capacity, power plant, power take off and counterweight.

It retains all the strength and other advantages of the 75. It has the same interchangeability of booms, shovel, crane or dragline. It will handle a crane boom up to 50 feet in length and can be counterweighted for unusual stability. When a plant has a 60 and the time comes when larger capacity is needed, by substituting a Lorain 75 power plant and accessories a full 1¼ yard machine is obtained.

Arthur R. Wilfley Dies

Arthur R. Wilfley, the inventor of the concentrating table which bears his name, was born in Maryville, Missouri, April 29, 1860. Shortly after his parents moved to Kansas City, Missouri, where he received his early education.

In 1878 Wilfley turned to mining and for some years worked as a miner and prospector. At this time he noticed that the lead-silver ore was irregularly deposited in masses of low grade iron sulphide and lead-zinc-iron sulphide, and Wilfley turned his attention to devising a method to concentrate these sulphides and to separate the lead from the zinc. His attempt to devise a method of separating the minerals and concentrating the salable minerals was perhaps at first directed more toward concentrating the heavy iron than in separating the zinc, but the table, though not making a complete separation of all minerals, did concentrate the heavy minerals and also separated some of them from one another. Mr. Wilfley's first patent was received in April, 1897. The introduction of these tables throughout the world was rapid and as first built was developed to such a point of perfection that practically no change has ever been made in its design.

In 1912 Wilfley was operating a slime concentrating plant, near Silverton, on tailings out of Silver Lake as deposited there by the Stoiber mills. Previous to 1912 he had developed a slime table, including the double decker slimer, and these were used in this slime mill. However, he discontinued the use of his slimers and put in the flotation system. Early in 1900 he conceived the idea of a pump for sand and slimes and during his work at the slime plant at Silver Lake he continued experimental work during the years of 1920 and 1921. Manufacturing and selling of this pump was begun in 1922.

This pump is now in use in practically every country in metallurgical operations and also in cement and chemical fields. Its most valuable feature is in the elimination of the customary stuffing box.

In 1921, when on a trip to Tonopah, Nevada, he became ill and was taken to a hospital in San Francisco, where he lay for many months. However, he kept himself alive until February 20, 1927, when he died at Whittier, California. Despite his illness, in 1922 he began the developing of a porcelain acid pump, which just before his death he felt had reached completion.

Oro Manganese Steel

The Kensington Steel Company has issued a folder dealing with Oro Electric Manganese steel castings which it manufactures. This manganese steel is described as a quality product and in order to maintain high standards some of the important requirements in connection with the manufacture are as follows:

The equipment throughout the plant must be of the best and most modern, including automatically controlled electric furnaces for melting and heat treatment, and all the necessary equipment for proper preparation of the molding sand, the facing sand, cores, etc.; the equipment for grinding, drifting and straightening must be of the correct type; a careful check must be kept upon the chemical analysis and the physical qualities of each and every heat poured; and rigid inspection of the finished castings. The circular states that all of these requirements are met in the organization and equipment of this company.

Rock of Ages Corporation Promotes Athol R. Bell

We are informed that the directors of the Rock of Ages Corporation have promoted Athol R. Bell to a part ownership in the business. Mr. Bell has been identified with Barre Granite since 1918 when he became Secretary of the Barre Granite Manufacturers Association. His connection with the Rock of Ages concern began in 1923.

Salem Elevator Buckets

The Weller Manufacturing Company has recently issued a circular describing the Salem Elevator Buckets. These are made in the following types: Standard front, low front and special types, as reinforced back, reinforced front and ends, perforated, digging and toothed edge.

Buckets of 18 gauge and lighter, also buckets 10 inches by 5½ inches and larger of 16 gauge, have reinforcement strip of steel across the back where punched.

This firm also makes Favorite elevator buckets, Buffalo, elevator buckets, Rialto elevator buckets, and V type elevator buckets for grain, Malleable iron elevator buckets, and standard steel elevator buckets, for handling cement, sand, gravel, crushed stone, etc., and also a complete line of elevating, conveying and power transmitting machinery.

Joah Etchells Returns to Richard K. Meade

Mr. Joah Etchells who has been acting for the last two years as Chief Engineer for the National Cement Company, Montreal, Quebec, has returned to his former employers, Richard K. Meade and Company, Baltimore, Md., and will be chief engineer for the above organization.

Mr. Etchells is a graduate engineer of the University of Pennsylvania and has had many years' experience in the design, construction and operation of cement, lime and plaster plants. He was chief engineer for Richard K. Meade and Company during the design and construction of the National Cement Company's new plant at Montreal.

Fifty Thousand Dollars for Suggestions

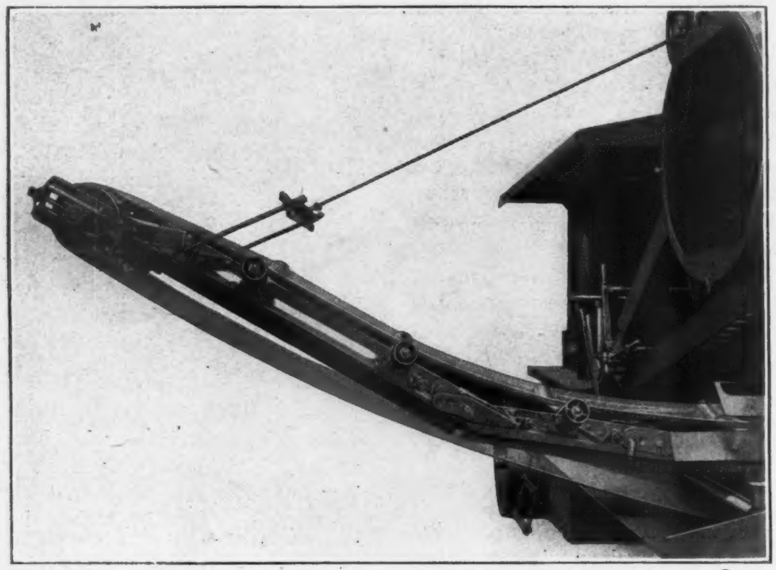
Awards amounting to $48,400 were paid to 4,405 employes of the General Electric Company during 1926 for suggestions which either improved working conditions or tended to increase the efficiency of the company's operations. During the year 13,703 suggestions were offered, an increase of 2,500 over the previous year and more than 32 per cent were accepted.

The awards, which ranged up to $1,000 and averaged $11 per person, were divided among the company's factories as follows:

Schenectady	$20,130
River Works, Lynn...	5,875
West Lynn Works....	3,130
Pittsfield	5,620
Erie	2,784
Fort Wayne	6,225
Bridgeport	1,650
Other plants	2,986
	$48,400

P & H Conveyor

Another part of the P & H trencher that has undergone considerable development in the past few years is the conveyor. The Harnischfeger Corporation now offer a new conveyor that is constructed to meet all conditions arising in the field. It can instantly be shifted by power from one side to the other or to any intermediate point.



New P and H Conveyor

By pulling one pin it is convertible from the cradle type to a hinged and cable supported type, which gives the advantage of raising or lowering the discharged end in case of loading trucks or when necessary to handle extra spoil due to cave-ins or extra depth or width. This is also very desirable when moving the machines from job to job as the conveyor can be instantly raised by power for travel clearances.

In this conveyor there have been eliminated the outside frame members; in its place is used a center frame or back-bone construction. This eliminates the possibility of dirt hitting the frame and landing on the lower side of belt causing wear and slippage.

The old conical belt rollers have also been eliminated and straight ones used instead. This construction forms a better trough and does away with the dirt guides which incidentally take up considerable carrying space of the belt and which by rubbing continuously on the belt wear off the rubber facing, shortening its life and creating an unnecessary belt expense.

S. R. Wright Retires

According to a report Solon R. Wright, who for 20 years has been vice-president of the South Berkshire Lime Company, recently retired from that company.

New Air Driven Portable Hand Saw

An automatic portable hand-saw, operated by compressed air, has been devised by the Ingersoll-Rand Company. By a mere shift of blades, the pneumatic hand-saw may be put to work in sawing wood, soapstone, Bakelite, wallboard, cables, copper, and other materials. Cross-cut or rip blades for different types of work are available. It cuts timber; does trimming work on buildings and scaffolding; and can be used for repair work.

In sawing wood, the portable air-driven hand-saw can be operated 20 times as fast as a workman can ply his saw, and in this, as well as in all other work, it can be operated continuously without fatigue to the operator. Its weight is such that it can be easily carried about and handled by the workman. The 8-inch size weighs only 23 pounds.

One outstanding feature of this new air saw is its safe-guard against accidents. The design combines the Ingersoll-Rand 3-cylinder type of air motor, long in use in I-R grinders and light-weight drills, with a safety saw guard.

The safety guard is of a telescopic nature. It opens when the saw is applied to the material, and it automatically closes and locks in position as the cut is completed. It affords complete protection against accident or damage to the blade. It has an adjustable stop so that the saw can be set for the required depth

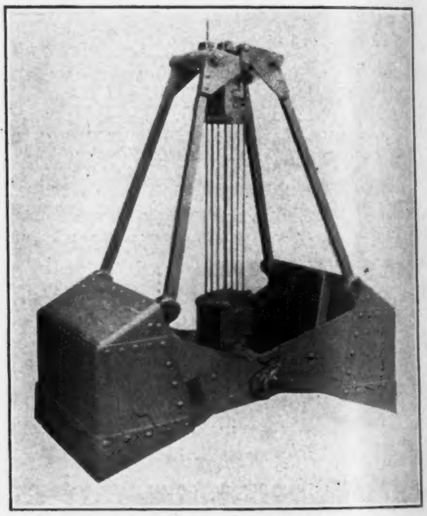
The 3-cylinder air motor is of the balanced type, smooth running, and free from breakdowns. All wearing parts, including the cylinders, are renewable. The saw is being manufactured in three sizes, known as B6, B8, and B12 and takes 6-inch, 8-inch, and 12-inch blades, respectively.

New Hayward Bucket

Among the new developments of the Hayward Bucket Company is the design of a rope reeved type of digging clam shell bucket. This has been designed especially for use with crawler cranes, truck cranes and similar equipment. This type of bucket is designed to stand up under the hardest kind of service and still remain within the weight and capacity limits of the types of machines for which it is intended.

The reeving of the bucket is variable so that it may be closed by means of five or seven sheaves, thus the closing power can be adjusted to suit the digging or handling condition. Naturally the fewer the sheaves the faster the operation of the bucket but with a corresponding decrease in closing power.

Not only is the digging power of the crawler or truck hoist increased by the sheave ratio of this bucket but also by operating the bucket in the bight of the line the lifting power is doubled and twice the ordinary load may be carried.



New Hayward Bucket

This bucket will dig any material that does not have to be blasted and the flexibility of sheave ratio permits of its accommodation to meet practically any digging condition where crawler or truck cranes are used. In loam or sand quick operating is obtained by the five sheave bucket while in hard pan or clay where digging conditions are severe the seven sheave permits of efficient excavation.

J. E. Hanrahan Promoted

We are informed that J. E. Hanrahan, for the past year and a half traffic manager for the Knickerbocker Cement Company, has been appointed traffic manager for the Port of Albany. Mr. Hanrahan succeeds John Harvey who has resigned.

Recent Patents

The following patents of interest to readers of this journal recently were issued from the United States Patent Office. Copies thereof may be obtained from R. E. Burnham, patent and trade-mark attorney, Continental Trust Building, Washington, D. C., at the rate of 20 cents each. State number of patent and name of inventor when ordering.

1,617,345. Spiral separator. Frank Pardee, Hazelton, Pa., assignor to Anthracite Separator Co., same place.

1,617,401. Coal-mining apparatus. Nils D. Levin, Columbus, Ohio, assignor to Jeffrey Mfg. Co., same place.

1,617,535. Concrete wall construction. Charles D. McArthur, Pittsburgh, Pa.

1,617,688. Rotary screen. Edward O'Toole, Gary, W. Va.

1,617,746. Concrete form. Arthur Denger, Davenport, Iowa.

1,617,820. Extension side loader. Edward H. Mortag, Milwaukee, Wis., assignor to Koehring Co., same place.

1,617,927. Process of manufacturing artificial stone. Oscar A. Tanner, Verona, Pa.

1,617,929. Construction of reenforced-concrete floors, etc. Giovanni Ventolino, Brooklyn, N. Y.

1,617,941. Mining apparatus. John H. Crawford, Harrisburg, Ill.

1,618,295. Manufacture of Portland cement. Carl Pontoppidan, Holte Copenhagen, Denmark, assignor to F. L. Smidth & Co., New York, N. Y.

1,618,421. Concrete wall construction. Neal Garrett, Berkeley, Cal.

1,618,512. Cement mixture. Frederick H. Christiansen, Huntington Park, Cal.

1,618,578. Sledded scoop. Robert T. Cummings, Spokane, Wash.

1,618,826. Shank and cutter tips for pulverizers. Joseph L. Hiller, Mattapoisett, Mass.

1,619,083. Finishing-machine for concrete roads. Glenway Maxon, jr., Milwaukee, Wis.

1,619,145. Combination tandem concrete-mixing machine. Edward H. McMillan, Oakland, Cal.

1,619,159. A frame for steam shovels. Addison E. Rudy, Matewan, W. Va.

1,619,297. Concrete gun. Roy C. Hackley, San Francisco, Cal.

1,619,321. System of concrete construction. Arthur E. Troiel, Oakland, Cal.

1,619,614. Road-building machine. Fred M. Hargrave, Cedar Rapids, Iowa.

1,619,626. Discharge mechanism for mixers. Joseph H. Mosel, Lakewood, Ohio, assignor to Lakewood Engineering Co., same place.

1,619,733. Aggregate-cement tile. George N. Jeppson, Worcester, Mass., assignor to Norton Co., same place.

1,619,734. Terrazzo tile and method of making the same. George N. Jeppson and Carl L. Leafe, Worcester, Mass., assignors to Norton Co., same place.

1,619,933. Form-tie for concrete structures. John B. Hawley, jr., Minneapolis, Minn., assignor to Hawley Invention, Inc., same place.

1,620,078. Stone-crusher. Edward F. Cookinham, Frankfort, N. Y., assignor to Acme Road Machinery Co., same place.

1,620,132. Reversible-point dippertooth. Charles A. Psilander, Youngstown, Ohio, assignor to American Manganese Steel Co., Chicago, Ill.

1,620,287. Concrete-mixer. Howard Powers, Marietta, Ohio.

1,620,514. Art of molding concrete or cementitious structures. Christian Brynoldt, Pittsburgh, Pa., assignor to Blaw-Knox Co.

1,620,575. Vibratory screen. William F. Schadel, Charleston, W. Va., assignor to Kanawha Mfg. Co., same place.

New Incorporations

New Boston Street Sand & Gravel Co., Woburn, Mass. $100,000. Benedette Generazio, Newton Upper Falls; Angelo De Angelis, East Boston; William V. Hayden, Newtonville.

West Michigan Core Sand Co., Grand Rapids, Mich., incorporated by Nugent Sand Co., to work Pigeon Hill.

Muskee Sand Co., Harry R. Waltman, Millville, N. J. $200,000 pfd.; 4,000 shares common, no par.

J. E. Baker Co., Inc., St. Petersburg, Fla. $50,000. Building materials. Jefferson D. Stephens, J. E. Baker.

United Asphalt Brick Corp., R. H. Bichler, 26 E. 23rd St., Kansas City, Mo. $2,500,000.

Carthage Marble Corp., Carthage, Mo. $14,000,000. K. D. Steadley, Pres. & Gen. Mgr.; G. J. Busboom, V. P.; W. E. Carter, Treas.; H. F. Mills, Sales Mgr.; B. L. VanHoose, Director. Merger of F. W. Steadley & Co., Consolidated Marble & Stone Co., Spring River Stone Co., Carthage Marble & White Lime Co., Carthage Marble & Bldg. Stone Co., Ozark Quarries Co., and Lautz Missouri Marble Co.

Sinclair Marble & Stone Co., George A. Sinclair, 6914 Noonan Ave., St. Louis, Mo. $40,000.

Schreiner Marble & Tile Co., St. Louis, Ho. $10,000. F. Schreiner, M. Schreiner, 700 Leland St., P. J. Muschong.

Cape Silica Co., Cape Girardeau, Mo. $250,000. J. W. Ford, Dr. Dan P. Scott, D. C. Smith, Dr. Fred C. Hamilton, Ed. J. Taron, Kankakee, Ill.; F. X. Bergeron, Bourbonnais, Ill.; Will Bender, Charles Bender, Naperville, Ill.

Bloomington Limestone Co., Bloomington, Ind. $200,000. S. C. Freese, R. H. Kelley, C. L. Rawles.

South Lakewood Sand & Gravel Co., South Lakewood, N. J. 500 shares no par. Wilfred B. Jayne, Jr., Lakewood.

Parks Granite & Power Co., Elkin, N. C. $100,000.

Tucson Rock & Sand Co., Albuquerque, N. Mex. $100,000.

Acme Sand & Gravel Co., Cincinnati, O. $15,000. Russell De Salvo, Joe De Salvo, Tony De Salvo, Frank De Salvo, Edwin G. Becker.

Lewis County Gravel Co., Centralia, Wash. $30,000. Frank C. Knowles, Ernest Rector, W. E. Buell.

Magnesite & Gypsum Products Corp., Little Ferry, N. J.

Mario Trap Rock Co., Wilmington, Del. $600,000.

Dings Wins Title to Patent

A mandatory injunction decreed by the U. S. District Court of the Eastern District of Wisconsin in favor of the Dings Magnetic Separator Company, of Milwaukee, Wisconsin, was affirmed by the U. S. Court of Appeals on January 18, without modification.

This injunction restrains a competitor from building ventilated magnetic pulleys which infringe patent No. 1,369,516 and is the result of an action brought by the Dings Co., against a manufacturer of magnetic pulleys. The suit which has now been decided in favor of the Dings Magnetic Separator Co., establishes the fact that this company is the owner of said patent on ventilated pulleys and that others offering that construction are infringing.

The magnetic pulley has long been used in the separation of stray iron in grinding and crushing plants and in many lines of manufacture such as feed mills, foundries, potteries, chemical plants, etc. The ventilated magnetic pulley design provides surfaces within the pulley for the radiation of heat generated in the magnet coils and permits air to circulate constantly through the pulley, thus dissipating the heat.

The decision in the suit referred to establishes the Dings Magnetic Separator Company, of Milwaukee, Wisconsin, as the only company now lawfully furnishing ventilated magnetic pulleys, covered by this basic patent.

Mr. George W. Gimlich has been appointed manager of the Harnischfeger Sales Corporation branch at Dallas, Texas. Mr. Daniel J. Murphy, former manager at Dallas, will open a new office at Baltimore, Maryland.

DISTRIBUTION OF CEMENT

Portland cement shipped from mills into States in December, 1925 and 1926, and January, 1926 and 1927, in barrels*

Shipped to	December 1925	December 1926	January 1926	January 1927
Alabama	108,906	117,426	129,291	132,569
Alaska	132	297	165	....
Arizona	61,646	39,536	38,869	54,088
Arkansas	43,281	42,245	46,708	46,014
California	938,721	901,526	931,238	998,230
Colorado	30,872	31,711	29,203	28,050
Connecticut	56,260	52,141	†40,300	34,587
Delaware	13,680	6,528	†9,019	11,170
District of Columbia	57,119	64,457	†35,304	50,552
Florida	439,786	317,402	483,824	283,031
Georgia	69,046	110,139	80,129	119,770
Hawaii	20,735	25,732	10,757	22,491
Idaho	15,993	13,199	19,198	15,085
Illinois	407,808	446,515	323,947	301,829
Indiana	114,856	108,771	85,724	74,589
Iowa	41,325	37,153	28,439	38,157
Kansas	87,368	88,010	56,598	68,122
Kentucky	63,382	62,172	35,560	42,851
Louisiana	74,464	89,843	65,695	116,633
Maine	7,028	6,255	20,310	6,295
Maryland	85,377	135,181	†85,495	135,015
Massachusetts	133,365	72,231	†101,212	70,354
Michigan	302,889	292,167	222,061	258,848
Minnesota	62,943	40,916	66,063	41,396
Mississippi	34,740	60,858	44,140	51,325
Missouri	207,230	152,647	137,343	113,581
Montana	7,382	6,455	9,716	7,261
Nebraska	34,633	26,933	23,788	22,675
Nevada	4,015	3,150	2,508	2,724
New Hampshire	22,586	18,340	17,081	16,172
New Jersey	329,054	255,744	†257,544	227,489
New Mexico	10,258	13,639	†12,019	12,503
New York	889,639	788,046	†592,584	697,992
North Carolina	152,699	183,912	81,764	141,582
North Dakota	2,474	2,439	3,338	3,575
Ohio	339,030	312,336	220,728	226,786
Oklahoma	148,354	120,560	101,087	164,266
Oregon	46,531	47,637	53,995	35,715
Pennsylvania	597,328	469,376	†423,443	363,607
Porto Rico	....	13,250	....	2,550
Rhode Island	26,721	19,813	†18,409	19,352
South Carolina	54,545	31,523	44,723	42,537
South Dakota	6,379	3,625	6,413	5,094
Tennessee	80,322	82,556	66,379	86,485
Texas	284,061	303,770	270,231	362,004
Utah	21,135	12,944	10,655	13,356
Vermont	4,066	3,844	†2,072	5,606
Virginia	72,698	61,351	61,645	62,199
Washington	82,364	90,856	72,393	104,608
West Virginia	63,066	63,680	39,983	47,871
Wisconsin	77,100	95,776	60,400	76,148
Wyoming	7,698	7,430	5,797	5,972
Unspecified	8,140	396	†17,254	23,808
	6,851,500	6,354,439	†5,602,541	5,894,569
Foreign countries	65,500	77,561	71,459	73,431
Total shipped from cement plants	6,917,000	6,432,000	5,674,000	5,968,000

*Includes estimated distribution of shipments from three plants in December, 1925, and January, 1927; from four plants in January, 1926; and from five plants in December, 1926.
†Revised.

Production, shipments, and stocks of finished Portland cement, by districts, in February, 1926 and 1927, and stocks of barrels in January, 1927

Commercial District	February Production 1926	February Production 1927	February Shipments 1926	February Shipments 1927	Stocks at end of February 1926	Stocks at end of February 1927	Stocks at end of January 1927*
Eastern Pa., N. J., & Md.	2,447,000	2,353,000	1,137,000	1,708,000	5,115,000	5,761,000	5,116,000
New York	288,000	229,000	145,000	215,000	1,590,000	1,452,000	1,438,000
Ohio, Western Pa. & W. Va.	739,000	865,000	402,000	543,000	2,792,000	2,942,000	2,620,000
Michigan	288,000	263,000	237,000	334,000	1,947,000	2,021,000	2,093,000
Wis., Ill., Ind., & Ky.	775,000	450,000	649,000	652,000	3,700,000	3,239,000	3,441,000
Va., Tenn., Ala. & Georgia	1,029,000	*1,020,000	937,000	992,000	1,058,000	1,195,000	1,167,000
Eastern Mo., Ia., Minn. & S. Dak.	483,000	404,000	396,000	362,000	3,066,000	3,241,000	3,199,000
Western Mo., Neb., Kan. & Okla.	361,000	236,000	518,000	527,000	1,399,000	1,556,000	1,847,000
Texas	393,000	396,000	400,000	382,000	488,000	475,000	461,000
Col., Mont., Utah	70,000	65,000	106,000	101,000	357,000	482,000	518,000
California	743,000	888,000	765,000	736,000	507,000	704,000	551,000
Oregon and Washington	115,000	199,000	128,000	174,000	366,000	488,000	463,000
	7,731,000	7,368,000	5,820,000	6,726,000	22,385,000	23,556,000	22,914,000

*Revised.

Domestic hydraulic cement shipped to Alaska, Hawaii, and Porto Rico, in January, 1927†

	Barrels	Value
Alaska	62	$ 203
Hawaii	29,285	62,989
Porto Rico	33,857	82,930
	63,204	146,122

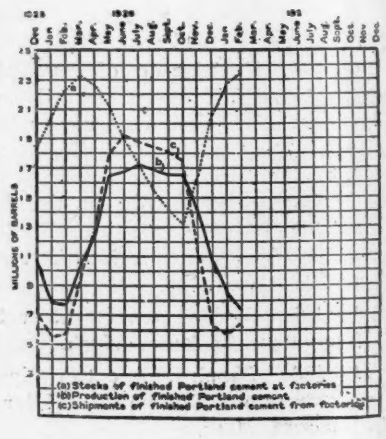
†Compiled from the records of the Bureau of Foreign and Domestic Commerce and subject to revision.

FEBRUARY CEMENT STATISTICS

February shipments of Portland cement show an increase of nearly 13 per cent as compared with January, 1927, and an increase of nearly 16 per cent as compared with February a year ago, according to the Bureau of Mines, Department of Commerce. February production shows a decrease of 890,000 barrels as compared with the production in January, 1927, due largely to the short month, and a decrease of nearly 5 per cent as compared with February, 1926.

Portland cement stocks are greater than at the end of any other month and are over 5 per cent in excess of the stocks at the end of February, 1926.

These statistics, prepared by the Division of Mineral Resources and Statistics of the Bureau of Mines, are compiled from reports for February, 1927, received direct from all manufacturing plants except three, for which estimates were necessary on account of lack of returns.



Two Eastern Lime Companies Elect Officers

At the recent annual meetings of the F. W. Waite Lime Company and the Jointa Lime Company the following officers and directors were reelected:

Waite Lime Company—President and general manager, Herbert J. Russell; vice-president, J. Irving Fowler; secretary, Russell M. L. Carson; treasurer, Frank J. Crome; directors, the officers and Fred J. Robertson.

Jointa Lime Company—President, J. Irving Fowler; vice-president, R. M. L. Carson; secretary, Hollis Stewart; treasurer and general manager, Herbert J. Russell; directors, the officers and George F. Cook and T. Coolidge Fowler.

Production, shipments, and stocks of finished Portland cement, by months, in 1926 and 1927, in barrels

	Production		Shipments		Stocks at end of month	
	1926	1927	1926	1927	1926	1927
January	7,887,000	*8,258,000	5,674,000	*5,968,000	20,582,000	*22,914,000
February	7,731,000	7,368,000	5,820,000	6,726,000	22,385,000	23,556,000
March	10,390,000	....	9,539,000	....	23,236,000	....
1st quarter	26,008,000	....	21,033,000	....	....	....
April	12,440,000	....	12,965,000	....	22,710,000	....
May	16,510,000	....	17,973,000	....	21,255,000	....
June	16,866,000	....	19,134,000	....	19,000,000	....
2nd quarter	45,816,000	....	50,072,000	....	....	....
July	17,134,000	....	18,812,000	....	17,301,000	....
August	16,995,000	....	18,583,000	....	15,718,000	....
September	16,571,000	....	18,087,000	....	14,188,000	....
3rd quarter	50,700,000	....	55,482,000	....	....	....
October	16,596,000	....	17,486,000	....	18,334,000	....
November	14,193,000	....	11,276,000	....	16,243,000	....
December	10,744,000	....	6,432,000	....	20,616,000	....
4th quarter	41,533,000	....	35,194,000	....	....	....
	164,057,000	....	161,781,000	....	....	....

*Revised.

EXPORTS AND IMPORTS*

Exports of hydraulic cement by countries, in January, 1927

Exported to	Barrels	Value
Canada	1,944	$ 8,844
Central America	8,745	24,938
Cuba	12,562	31,670
Other West Indies and Bermuda	5,054	12,528
Mexico	6,174	20,089
South America	35,924	125,364
Other countries	4,943	30,639
	75,346	$254,072

Imports of hydraulic cement by countries, and by districts, in January, 1927

Imported from	District into which imported	Barrels	Value
Belgium	Florida	$ 57,858	$ 74,598
	Galveston	6,000	9,208
	Los Angeles	6,065	8,520
	Massachusetts	77,721	95,272
	Oregon	5,466	7,614
	Porto Rico	16,852	31,227
	Total	169,962	$226,439
Canada	St. Lawrence	525	977
Denmark and Faroe Islands	Porto Rico	3,000	4,518
France	New Orleans	131	520
	New York	300	1,047
	Total	431	$ 1,567
Japan	Hawaii	12,500	24,494
Netherlands	Porto Rico	4,257	6,487
United Kingdom	New Orleans	500	1,147
	Oregon	1,000	1,898
	Washington	1,000	2,134
	Total	2,500	$ 5,179
	Grand total	193,175	$269,661

Exports and imports of hydraulic cement, by months, in 1926 and 1927

	Exports				Imports			
	1926		1927		1926		1927	
	Barrels	Value	Barrels	Value	Barrels	Value	Barrels	Value
January	72,939	$ 216,431	75,346	$254,072	360,580	$ 576,717	193,175	$269,661
February	73,975	220,706	.....	....	314,118	527,948	......	....
March	69,080	205,647	.....	....	493,241	812,968	......	....
April	96,296	284,772	.....	....	257,302	398,114	......	....
May	78,601	224,365	.....	....	223,130	337,031	......	....
June	80,684	248,814	.....	....	335,570	495,744	......	....
July	130,822	370,220	.....	....	250,862	395,981	......	....
August	64,946	216,489	.....	....	350,638	560,532	......	....
September	70,920	239,174	.....	....	194,129	308,224	......	....
October	69,389	225,874	.....	....	263,403	386,385	......	....
November	76,598	238,103	.....	....	55,233	82,949	......	....
December	89,976	305,238	.....	....	151,850	246,293	......	....
	974,226	$2,995,833	.....	....	3,250,056	$5,128,836	......	....

*Compiled from the records of the Bureau of Foreign and Domestic Commerce and subject to revision.

New Butt Welding Machine

Among the many types of welding equipment which have been brought out in recent months, the automatic machines for electric arc welding are interesting. It was only a few years ago that the manual process was the only method. Yet in the last twelve months numerous new machines have appeared on the market for doing welding by machine which had formerly been done by hand.

The Lincoln butt welding machine is a further development of the machine driven carbon arc to the problems of welding. One ordinarily thinks of butt welding in terms of the resistance welder. The arc butt welder is not an alternative method of doing butt welding but is claimed to be a solution to a class of butt welding problems which the resistance welder cannot solve. As an instance of this, a plug may be welded into the end of a tube with the arc butt welder very easily although the job would be impossible with a resistance butt welder. A similar instance of applicability of the arc butt welder is that of welding a small diameter round bar to a large diameter bar. With the arc butt welder, the welding heat is applied to the joint by the carbon arc and the bars revolved to distribute the heat uniformly, pressure being applied to squeeze out the slag and complete fusion. The motor generator set used to supply current for the arc supplies direct current at 40 to 60 volts, the motor being a standard induction type.

Georgia Portland Cement Elects New Directors

At a recent meeting of the Georgia Portland Cement Corporation five additional directors were elected. These were: C. W. Skinner; J. B. Tarbutton; T. I. Harrison; W. S. Preetorius and Thomas J. Hamilton. Others already on the board are: J. Lee Hankinson, L. H. Charbonnier, John C. Hagler, and Herbert C. Lorick. The officers named for the Company are: J. Lee Hankinson, president; John C. Hagler, vice-president, and H. W. Neill, secretary-treasurer.

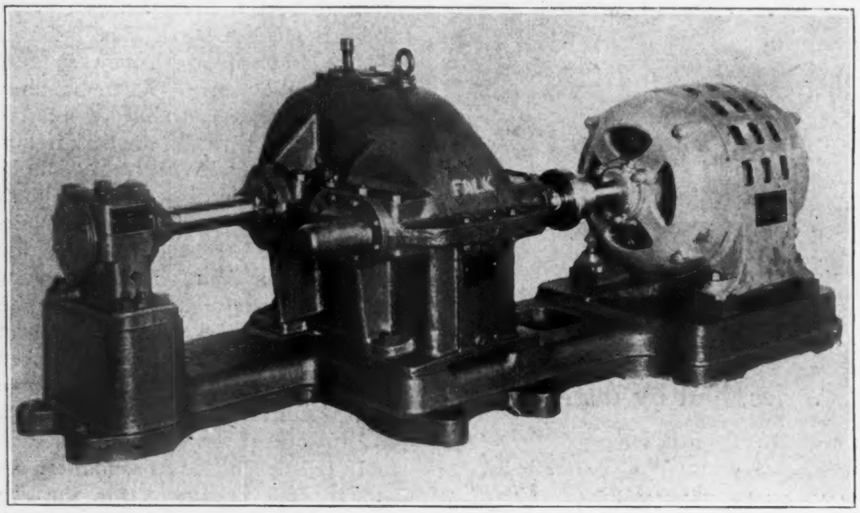
Concrete Men Organize

We are informed that eighteen manufacturers of concrete products have organized the Kent County Concrete Products association with the following officers: President, Harry Cromline; second vice president, J. A. Campbell; secretary-treasurer, C. T. Jenks. The officers, Garrett Dieterman and Charles Johnson comprise the board of directors.

New Falk Speed Reducers

The Falk Corporation has brought out a new line of speed reducers. These units feature the Falk continuous tooth, all steel herringbone gears. Like the units previously built by this company, the gears are precision made, silent and give high efficiency.

Special design of housing eliminates any internal ribs, projections or complicated cores. Lubrication has in this way been simplified and all possibility of dirt or core sand working into the gears is removed. Added features are the airplane type, steel-backed, babbitt-lined bearings that are capable of carrying heavier loads and an improved automatic continuous lubrication system.



Falk Speed Reducer Coupled to Motor

Based on years of experience, this line covers a certain number of standard reduction ratios. Standard motor beds have been adopted for these units. The reducers are made in three types—single reduction for ratios up to 9 to 1, double reduction for ratios up to 70 to 1, and triple reduction for ratios up to 300 to 1.

Hetherington and Berner to Make Complete Line for Pit and Quarry

Announcement has just been made by Hetherington and Berner of the completion of plans for manufacturing a complete line of gravel producing equipment. This new manufacturing policy was placed in effect with the first of the year and marks a great forward step in the progress of this well-known firm. Hetherington and Berner have been in business for sixty years, and their Standard semi-steel and Dreadnaught manganese lines of sand and gravel pumps are firmly established throughout the industry. In addition to this line of business Hetherington and Berner have extensive plans for fabricating structural steel for buildings, and operate a large foundry.

The co-ordination of these activities has resulted in the development of the new lines of manufacture, which will place this firm in the forefront of manufacturers supplying the pit and quarry industries. One of the lines to be featured under the new manufacturing program will be steel gravel bins. Steel gravel bins are rapidly replacing wood and concrete bins in many plants because of the features of permanence and strength, and because their cost is no more than bins of less satisfactory materials.

Other equipment to be used in gravel pits, stone quarries, etc., that will be included in the new lines are steel A frames, structural steel masts, steel barges which will be shipped either assembled or knocked down, stone boxes, suction cages and all special valve and elbow equipment that is in use in a pit and quarry plant.

A line of centrifugal water pumps also will be featured. The present Standard and Dreadnaught lines of dredging pumps have proved to be successful because of their rugged construction, high efficiency and freedom from repair expense. The present Standard line of H and B pumps is being manufactured now in 4 inch, 6 inch and 8 inch sizes for water pumping. The complete line of H and B equipment will be handled by jobbers throughout the country. Hetherington and Berner have just completed an extensive survey of conditions throughout the pit and quarry industry and predict a most successful year in this business.

The Novo Engine Company has added the Construction Equipment Company, Columbia, South Carolina, to its list of authorized distributors.

U. S. Production of Bauxite During 1926

The production of bauxite in the United States in 1926 was 392,250 long tons, valued at $2,415,200, an increase of 24 per cent in quantity and 21 per cent in value as compared with the domestic production of 316,540 long tons, valued at $1,988,250, in 1925, according to a statement prepared by James M. Hill, of the Bureau of Mines, Department of Commerce.

The production of bauxite in the Arkansas field was 371,570 long tons in 1926, an increase of 25 per cent as compared with 1925. The eastern field, including Georgia and Tennessee, produced 20,680 tons, an increase of 2 per cent as compared with 1926. No bauxite was produced in Alabama or Mississippi in 1926.

The following is a statement of domestic bauxite sold by producers to industries in 1924 to 1926, inclusive, in long tons:

Year	Aluminum	Chemicals	Abrasives, refractories, and cement	Total
1924...	225,780	54,870	66,920	347,570
1925...	173,040	67,420	73,980	314,440
1926...	241,850	77,960	72,440	392,250

Domestic bauxite was quoted throughout the first half of the year as follows: Crushed and dried, $5.50 to $8.50; pulverized and dried, $14.00; calcined and crushed, $17.00 to $20.00 a long ton, f. o. b. shipping point. Beginning with August quotations were changed to read "No. 1 chemical ore, over 60 per cent Al_2O_3, less than 5 per cent SiO_2 and less than 2 per cent Fe_2O_3, and the price quoted was $8.00 a ton f. o. b. Georgia mines the balance of the year. Domestic producers reported value f. o. b. shipping point at $5.00 to $8.00 a ton, the average for the whole domestic production being $6.16 a long ton.

Imports of bauxite in 1926 amounted to 281,644 long tons, valued at $1,187,497 (an average of $4.22 a ton), a decrease of 20 per cent in quantity as compared with imports in 1925. Imports were chiefly from the Guianas and Dalmatia, though some French bauxite was imported. Imported bauxite is used chiefly by the chemical and cement industries on the eastern seaboard. Quotations on foreign bauxite were: Dalmatia, low silica, $5.00 to $6.50; Istrian, $5.50 to $7.00; and French red, $6.00 to $7.50 c. i. f. a metric ton.

Exports of bauxite, including bauxite concentrates (alumina), in 1926 totaled 87,770 tons, valued at $4,741,260 ($54.02 a ton), an increase of 12 per cent in quantity as compared with exports in 1925. Exports were largely to Canadian and Norwegian aluminum plants.

New Drillers Hand Book by Armstrong

The Armstrong Manufacturing Company has recently issued a book under the above title written by G. R. Watson. This book discusses the subject of dressing drill bits and contains suggestions for this work to suit the formation being drilled and make the drills cut faster. Eight important factors should be given consideration in the design and method of dressing a drill bit, namely: angle of clearance; angle of penetration; wearing surface; reaming surface; area of crushing face; area of and cross section of drill bit. Each of these factors are discussed and illustrated by means of line drawings.

The subject of drilling in different formations is then dealt with and information given as to how drills should be prepared when working in different materials such as hard lime, soft lime, granite, shale, clay or very soft lime. Suggestions are also given on the proper methods of heating, forging and hardening drill bits, followed by some important don'ts to be observed when performing this work.

Some of the equipment made by this company are illustrated and described. These comprise bit furnaces, drill bits, type A, type C and type D and the bit dressing machine. The operation of the bit dressing machine is described very fully, each operation from the placing of the drill bit on the machine ready for insertion in the heating furnace to the finish forging operation is recorded very minutely. The book is valuable for all users of drill bits being full of useful data and information.

Wonder Drum Hoists

The Construction Machinery Company manufacture three types of hoists, single, double and triple drum. The single drum non-reversible hoist is especially adapted for operating single platform material elevators, buckets, pulling cars up inclines, loading and unloading and similar work requiring the use of a single, non-reversible hoisting drum. This machine is designed so that a second drum can be attached later in the field when it then becomes a double drum non-reversible hoist. The clutch lever, foot brake pedal and hoist drum pawl are conveniently grouped at side of hoist so operator stands within easy reach of engine clutch and engine accelerator.

The double drum non-reversible hoist is designed so that a third drum or boom swinger can be attached in the field. All operating levers, brakes and pawls are banked at rear of hoist. Operator works hoist from one position and has full forward view of all hoisting and working operations. The single or double drum hoist can be furnished with engines ranging from 15 to 60 horse power. Load capacity, single line is 2,000 to 8,000 lbs. at 165 feet per minute or 1,500 to 6,000 lbs. at 200 feet per minute. Drum capacity, ½ inch cable is 1660 feet.

The triple drum hoist is adapted for operating clam shell or orange peel buckets, stiff leg dericks, dragline and excavating work, etc. A similar arangement of all operating levers and brakes at the rear of the hoist is followed as used on the double drum units. The triple drum hoists are furnished with engine having rated horse powers ranging from 30 to 60. The drum capacity, ½ cable is 1660 feet. Load capacity single line is 4,000 to 8,000 lbs. at 165 feet per minute or 3,000 to 6,000 lbs. at 200 feet per minute. The size of the bed plate is 41 by 174 inches.

Valley Forge Cement Plant Buildings Planned

At a recent meeting of the Valley Forge Cement Company plans were submitted for the erection of 13 buildings near the quarry deposits. The machine shop and store house, 40 feet wide by 176 feet long by 16 feet high, will be of concrete and steel construction. Grinding room, 60 feet long and approximately 45 feet wide. This building to house two 7 foot x 42 foot tube mills, both for wet grinding. Small concrete and steel building approximately 20 feet x 20 feet to house a number 6 Williams crusher. Storage building approximately 250 feet long by 80 feet wide by 60 feet high.

The crusher building will house one 48 inch by 60 inch Traylor jaw crusher and a number 9 Williams mill. This building will be about 62 feet long, 40 feet wide and one story high. The kiln house will house two rotary kilns, 225 feet long with all the necessary machinery and will be 270 feet long and 55 feet wide. The building for the concrete flue entering the stack at the end of the kilns is to be 62 feet long, 28 feet wide and 25 feet high.

The concrete stack will be about 240 feet high and is to be 14 feet inside diameter at the base. Sixteen concrete silos of various sizes will be erected with overall dimensions of 50 feet by 150 feet and about 90 feet high at the extreme point.

The coal house will be 112 feet long and 32 feet wide and will contain the coal dryers and three pulverizers together with the conveying equipment. A pack house and bag house is to be erected two stories high but the dimensions have not been decided at this time. A building for the transformers and compressors will be two stories high and approximately 60 feet by 60 feet. The office building is to be constructed about 60 feet by 60 feet, two floors high. All the buildings will be fireproof, being of concrete and steel construction, and where wood is used, as for the silo doors, this will be covered with sheet iron.

New Miami Scraper Booklet

The Miami Trailer-Scraper Company has recently issued a folder describing the Miami Scraper. It is claimed that the Miami winch installed on the Fordson Tractor furnishes all the power necessary to lift the scoop from the ground after loading and to dump the scoop. This power is also used to lift the scoop slightly in case it meets obstructions in loading. Through the use of the winch and the fact that the scraper is mounted on wheels the pan is always under control of the tractor driver. Depth of cut in loading and method of dumping is easily controlled from the driver's seat.

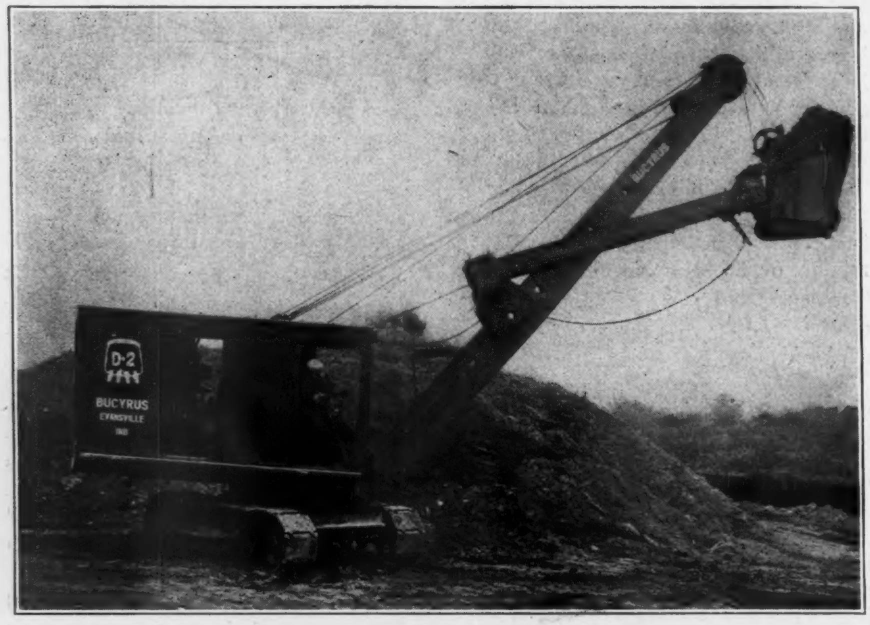
The mechanical construction and roller and bearing wheels tend to give the minimum of draw bar pull in all cases except loading when the full pull of the scoop is on the tractor. But in this position the features of this scraper come to good advantage, namely: that in no case can the tractor be stalled; that it is never necessary to back the scraper; that depth of cut can be varied; that the load can be lifted and dropped again when meeting obstructions. All this is accomplished by the tractor driver who simply engages and disengages the clutch of the Miami winch. The scraper can pick up its load going up hill, down hill or on the level. It can be dumped going up hill, down hill, moving backward, forward or standing still and it can also be backed into any position for dumping.

Atlantic Gypsum Elects

Albert Farwell Bemis of Boston was elected chairman of the board of the Atlantic Gypsum Products Company at the annual meeting held recently at Portsmouth, New Hampshire. George N. Roberts of Boston was elected president.

New Bucyrus Yard Shovel

The new Bucyrus D-2 one-yard Diesel shovel, convertible to dragline, clamshell and crane, has recently appeared on the market. It is the product of 47 years of Bucyrus experience in building excavating machinery. Lower fuel, yardage and upkeep costs, together with increased power, were guiding principles in the construction of this shovel. The combination of a high-speed digging cycle with the economy of Diesel power gives the shovel features of swift, economical operation.



Bucyrus One Yard Shovel

The power plant is a four-cycle full-Diesel engine. The fuel is fed into it mechanically, providing high economy of fuel consumption and avoiding the use of air compressor. It is claimed that the engine can be started from cold to full load in 20 seconds, no priming and preheating being necessary. The engine is mounted on a raised base which is bolted to the cast revolving frame—a mounting that provides a direct connection between the main machinery and engine, and which insures perfect alignment at all times. The center pintle construction relieves the vertical propelling shaft of all digging strains, and keeps the revolving frame centered on the base frame and protects the vertical propelling shaft from wear and breakage.

An improved rope crowd is used on the machine, which makes it possible for crowding and hoisting operations to take place individually, as well as simultaneously. The new straight boom of the shovel has all the advantages of the Bucyrus bent boom, with the added advantage that the machine operates better with the boom at low angles. Since this boom is lighter, the machine has a quicker swing and better stability.

The two-part hoist and the big drum used in the main machinery and on the boom insure proper tracking of the ropes and lengthen their life. Outside dipper handles insure that the full force of the engine is transmitted squarely behind the dipper. The light-weight box girder boom with outside dipper handles require less counterweight at the rear of the shovel—there is less flywheel effect to act against the swinging machinery, making the swing fast at every stage. An outstanding feature of the caterpillar mounting is its simplicity and fewness of parts, with more than sufficient tractive power to enable the excavator to climb up inclines as steep as thirty per cent.

Jeffrey Issues New Catalog

The Jeffrey Manufacturing Company recently issued Catalog number 437 describing the Jeffrey equipment for handling stone, gravel, sand, cement, gypsum, lime, slag, etc. The steel encased bucket elevators are built in standard sizes to meet every requirement calling for this type of elevator. They can be furnished with malleable or steel buckets of various styles, mounted on Detachable, Hercules or Peerless types of chains. The pivoted bucket carrier, which both elevates and conveys, lends itself to many uses, some of which are illustrated in this catalog. The pan conveyor is well adapted to the handling of abrasive or semi-abrasive materials, as none of the material comes in contact with the moving parts.

Steel apron conveyors with their overlapping continuous surfaces and overlapping steel containing ends are a most reliable and durable means for the handling of large quantities of loose material. These are made in various standard widths and weights of material, and with chains to suit conditions. Reciprocating plate feeders are used for regulating the flow of material to pulverizer, elevator or conveyor. The steel apron feeder is designed for handling material from a track hopper or bin to pulverizer, elevator or conveyor.

The following types of chain with attachments are made by this company and carried in stock: Detachable link; Hercules; Peerless; Reliance; Malleable roller; steel thimble roller; heavy duty, and drag chain. Flight conveyors and their driving mechanism are also illustrated. Belt Conveyor idlers have been given much thought by this company and three types are manufactured, plain bearing, bronze bushed bearing, and roller bearing construction. The power shovel is designed for unloading bulk material which is shipped in box cars and is to be unloaded into chutes, hoppers, elevators or conveyors. Illustrations and descriptions are also given of arm elevators, sand settling tanks, revolving screens, several types of bin valves, gates, pulverizing equipment and conveyor accessories.

New Type Welding Electrode

A new type of welding electrode which combines the characteristics of a fluxed electrode and the quality of bead finish and the cleanness in handling of a bare welding electrode has been introduced by the General Electric Company. Recommended for the general welding of steel, the electrode has a uniform flowing quality. The absence of sputtering or spattering, characteristic of the usual commercial bare welding wire, is one of the features of the new material. The elimination of the erratic arc condition leads to a deposit of more material with the same consumption of electrode per kilowatt-hour. The electrode penetrates quickly and produces high tensile strength and unusual ductility and elongation. The electrode, which has been designated GE type F, is furnished in 3/32-, 1/8-, 5/32-, 3/16- and 1/4-inch sizes.

Olean Sand and Gravel Corp. Elect Officers

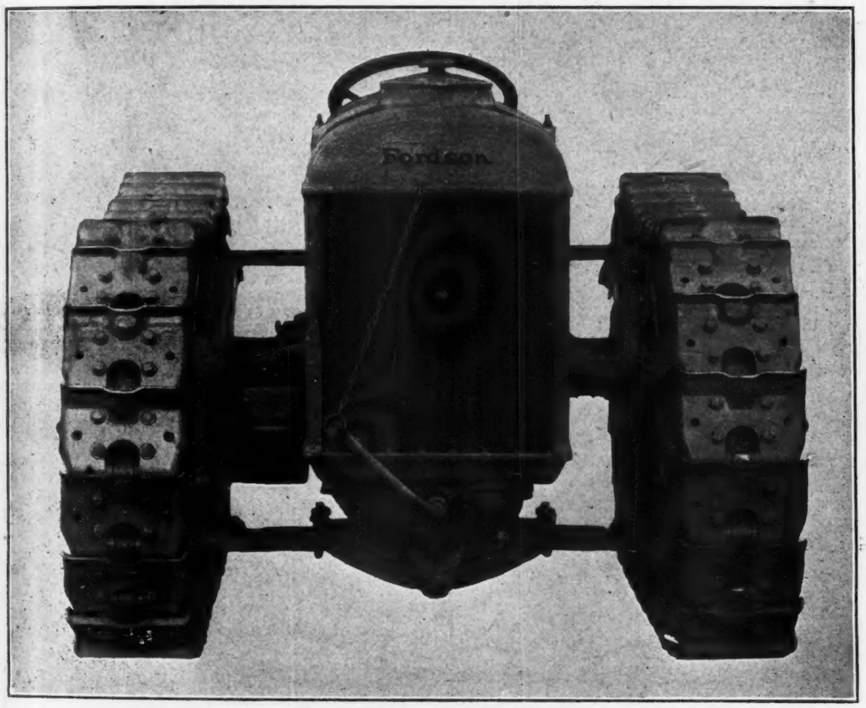
According to a report, at the annual meeting of the Olean Sand and Gravel Corporation that was held recently the following officers were elected, Thomas H. Quinn, president; W. H. Gallup, vice-president; P. H. Quinn, treasurer and H. R. Moran, secretary. William F. Packard was elected a director in the corporation.

New Belle City Crawler

The Belle City Manufacturing Company has recently put into production a wide track crawler for Fordson as a companion to its narrow track, which has been in successful use for sometime both at home and abroad working under the various difficult conditions required of this type of tractive power. The new model is styled standard gauge, and like the narrow gauge is clutch controlled, has full Timken roller bearing equipment, Alemite-Zerk oiling system, drop forged treads and saw steel clutch discs running in oil. The new machine has the same measurement between treads as between regular Fordson drive wheels, uses any standard drive pulley and accommodates any industrial equipment used on the wheel equipped tractor and that, without any special attachments.

When heavy equipment is attached to the crawler requiring a connection to the support of the front axles, the springs are replaced by heavy steel members attaching in the same manner as the springs. The steel axle is equipped with rubber bumpers which act as shock absorbers; ample additional strength and rigidity is given the main frame assemblies by the use of 1½ inch special steel radius rod or spacer which connects these two assemblies, passing under the tractor crank case.

Much thought has been given to obtain accessibility of all working parts and also simplicity of design. The crawler, when attached to a Fordson which is delivering its rated draw bar horse power, is warranted to give the desired performance, durability and draw bar pull. It delivers full power of motor at all times to one or both tracks whether straight ahead or on turns, and will turn around in its own length.



Belle City Wide Track Crawler

The additional width of this model is obtained: By substituting for the regular Fordson axle housings, internally ribbed steel housings of the same contour and with the grooves used for attaching equipment exactly the same distance apart as in the regular housings. By providing a front end or third point of suspension for the tractor, a heavy cast steel saddle or walking beam pivoted on a shaft passing through the Fordson front axle stirrup to this walking beam is bolted on either side heavy leaf springs whose outer ends are connected to the main frame assemblies by means of steel shackles. This assembly acts as a radius link and provides flexibility to the tracks.

Keystone Portland Cement Selects Engineers

Richard K. Meade and Company have been retained as designing and consulting engineers for the new plant of the Keystone Portland Cement Company which is to be built at Bath, Pennsylvania. The new plant will have a capacity of 3,000 barrels per day. This plant will employ the wet process and will be the second new modern plant to be built in the Lehigh District. It will be equipped with all of the latest improvements for the manufacture of portland cement and will be prepared to manufacture high testing, quick hardening cement, such as has been put on the market by a few of the newer cement plants. The new plant is to be built just outside of the Borough of Bath, Pennsylvania, and between the Lehigh mill and the town.

Among the officers of the company are: Mr. John Buckland, president; Mr. Fred B. Franks, vice-president and general manager, and E. J. Fox of Easton, Pennsylvania, treasurer. Mr. Franks is well known in the cement industry having originally built the plant of Wm. Kraus and Sons at Martins Creek, some twenty-five years ago. This plant was later purchased by the Alpha Cement Company. Mr. Franks then organized and built the plant of the Bath Portland Cement Company at Bath, Pennsylvania, which plant was sold some years ago to the Lehigh Portland Cement Company. Mr. John Buckland is president of the National Slag Company of Allentown, which plant is one of the largest producers of crushed slag in the East. Mr. Fox is a prominent attorney of Easton, Pennsylvania. He is also president of the Easton Trust Company and a former associate justice of the Pennsylvania Supreme Court.

New Jersey Lime Products Plant Near Completion

The new lime plant of the New Jersey Lime Products Corp., Ogdensburg, New Jersey, of which Richard K. Meade and Company, Baltimore, Maryland, are the engineers, is now nearing completion and it is anticipated will be burning lime about June 1. The present plant will employ a rotary kiln and will be the first unit of what is destined to be one of the largest lime plants in Eastern Pennsylvania. Its raw material consists of a very pure calcite. On burning, the latter falls to granules so that the lime will be in the granular condition so popular with the Eastern trade. The plant will also be equipped to manufacture pulverized lime.

The equipment is thoroughly modern and up-to-date. Oil will be used for fuel and the raw materials will be under the constant supervision of Richard K. Meade and Company, who will act as consulting engineers and chemists after the plant is placed in operation. This company has now in operation a pulverized lime plant and is also prepared to furnish pulverized limestone for agricultural purposes, asphalt filler, etc. The capacity of the lime plant will be 60 tons per day.

The Blaw-Knox Company is now maintaining its Philadelphia office at 332 Widener Building.

Rates for display advertisements in the Broadcast Section are given below. If you want to buy or sell used equipment, if you want a job or need a man, advertise your wants in Pit and Quarry. Advertisement copy for publication in the next issue should reach our office within one week after the date of this issue.

RATES PER INSERTION	1 Inch	2 Inches	3 Inches	4 Inches	5 Inches	6 Inches	8 Inches	9 Inches	10 Inches	12 Inches	15 Inches	20 Inches	30 Inches
1 Insertion	$3.75	$7.25	$10.75	$14.25	$17.75	$21.25	$28.25	$31.75	$35.25	$42.25	$56.25	$70.25	$105.00
2 Insertions	3.75	7.25	10.70	14.20	17.65	21.15	28.15	31.65	35.15	42.15	56.15	70.00	104.00
3 Insertions	3.75	7.20	10.65	14.15	17.55	21.05	28.05	31.55	35.10	42.05	56.05	69.75	103.00
4 Insertions	3.70	7.15	10.60	14.10	17.45	20.95	27.95	31.45	35.00	41.95	55.90	68.75	101.00
8 Insertions	3.65	7.05	10.50	14.00	17.25	20.75	27.75	31.25	34.80	41.75	55.70	67.50	98.00
13 Insertions	3.60	6.95	10.40	13.90	17.05	20.55	27.55	31.05	34.60	41.55	55.55	66.25	94.00
26 Insertions	3.50	6.75	10.20	13.70	16.65	20.05	27.05	30.65	34.20	41.05	55.05	64.00	88.00

INFORMATION—"*Broadcast*" space is sold by the advertising "inch." Each page contains 30 inches. The width of the page is divided into 3 columns, each 2¼ inches wide. Each column contains 10 inches measured the length of the column. Any space may be used measured by the *even* inch in height (not fractions), by 1, 2 or 3 columns in width. The size of a space is its height in inches multiplied by the number of columns in width. Example: a space 3 inches high by 2 columns wide is 6 inches. Copy changes made without additional charge.

Complete Service Publishing Company

538 South Clark Street **CHICAGO**

FOR SALE OR RENT

All equipment overhauled in our Shop is furnished in guaranteed condition, subject to thirty days' trial in service.

STEAM SHOVELS—RAILROAD TYPE

1—Model 80 Marion, Shop No. 1312, 4 yd.
3—70-ton Bucyrus. Shop Nos. 920, 939, and 1233. 2½-yd. dippers.
1—Model 60 Marion. Shop No. 2238, 2½-yd. dipper.
3—60-C Bucyrus. Shop No. 1286, 1388 and 1640, 2½-yd. dippers.
1—45-C Bucyrus. Shop No. 1202. 1¾-yd. dipper.

SHOVELS—FULL REVOLVING

2—50-B Bucyrus. Shop Nos. 3821, 4216, caterpillars, 26-ft. boom, 17-ft. stick and 1¾-yd. dippers. Oil burner.
1—37 Marion. Shop No. 4773, 32 ft. boom, 22 ft. dipper arm, 1¼-yd. dipper. Caterpillars.
3—Type "B" Eries, Shop Nos. 559 and 1027 have standard boom equipment. Shop Nos. 1219, 1484, 1614, 2144, 2152 and 3392 are high lift. All ¾-yd. steel caterpillars.
1—Osgood 18, Shop No. 1002, standard boom, ¾-yd. dipper. Steel caterpillars.
1—Model 21 Marion. Shop No. 4294, steel caterpillars, ¾ yd.
1—Model 21 Marion Gas-Electric. Shop No. 4550, caterpillars, standard boom, ¾-yd. dipper.
1—Type O Thew, Shop No. 1777, high-lift, traction wheels, 2/3-yd. dipper.
1—18-B Bucyrus. Shop No. 1870. ⅞-yd. dipper. Traction.

SIDE DUMP CARS

4—30-yd. Western, all-steel, air dump.
20—20-yd. Western, all-steel, air dump.
12—18-yd. Western, all-steel.
69—16-yd. Western, wood beds, air dump.
104—12-yd. Western Side Dump, wood beds.
4—6-yd. K. & J. Steel Sills Truss-rod doors. Located Burmaugh, Ky.
7—5-yd. K. & J. 36-in. ga. Steel draw-sills, wood beds.
21—5 yd. Western 36 in. ga., heavy duty, wood beds.
17—4-yd. K&J, 36 in. gauge, wood sills.
9—2-yd. Western, 36-in. ga., wood draw-sills, wood beds.
4—1½-yd. Western, 24-in. ga., wood beds.

STEAM SHOVEL PARTS

All repair parts on hand for Model 60 Marion and standard 70-ton Bucyrus Steam Shovels.
1—Std. boom, dipper arm and ¾-yd. dipper for Type "B" Erie.
2—32-ft. and 40-ft steel boom, drum, etc. for Type "B" Erie Crane.

LOCOMOTIVES

1—19x24 Baldwin 6-wheeled Saddle Tank. Shop No. 49553. Weight 67 tons, 180 lb. steam pressure. Air brakes.
1—19x24 Baldwin Mogul, Shop No. 30,314, wt. 61 tons, 180 lb. steam pressure, air brakes.
1—18x24 American Six-wheeled Switcher. Shop No. 47677, weight 52 tons, 170 lb. steam pressure.
1—18x24 Baldwin 6-wheeled Switcher. Shop No. 25044, wt. 50 tons, air brakes.
1—16x24 Davenport 4-wheeled switcher, Shop Nos. 858. Wt. 40 tons. Air brakes.
1—11x16, Standard Gauge Porter four-wheeled, saddle tank, Shop No. 6757, A.S.M.E. boiler. New 1922.
1—14x20 Davenport 4-wheeled saddle tank, Shop No. 2046, wt. 40 tons, 180 lb. steam pressure, A.S.M.E. boiler.
2—11x16 Vulcan 4-wheeled Saddle Tanks. 36-in. ga. Shop Nos. 1621 and 3411, wt. 21½ tons.
1—10x16 Porter 4-wheeled Saddle Tank. Shop No. 4251, wt. 19 tons, 165 lb. steam pressure.
1—10x16 Davenport, 36-in. ga. 4-wheeled Saddle Tanks. Wt. 19½ tons. A. S. M. E. and Ohio Std. boilers. New 1922.
2—10x16 Baldwin, 36-in. ga., 4-wheeled Saddle Tanks. Wt. 19½ tons. Shop Nos. 12161 and 28353.
2—9x14 Porter 36-in. gauge saddle tank Dinkies, Shop Nos. 6643 and 6960.
2—30-ton Climax Locomotives, 36-in. ga. New 1925.
4—7x12 Davenport and Vulcan, 24-in. gauge, 9-ton dinkies.
1—6-ton, 24-in. gauge Whitcomb Gas, gear drive, Shop No. 1259.

DRAGLINE EXCAVATORS

1—Class 24 Bucyrus. Shop No. 859, equalizing trucks, 100-ft. boom, 3½-yd. Page bucket. A.S.M.E. boiler.
2—Class 20 Bucyrus Draglines. Shop Nos. 740 and 813, 85-ft. booms, 2½-yd. dragline buckets. Skids and rollers.
2—Class 14 Bucyrus, steam operated. Shop Nos. 2140 and 3706, steel caterpillars, 60-ft. boom, 2-yd. bucket. A.S.M.E. boiler.
1—Class 14 Bucyrus, Shop No. 745, skids and rolls, 60-ft. boom, 2-yd. bucket.
2—No. 2 Monighan steam operated. Shop Nos. 789 and 1587, skids and rollers, 60-ft. boom, 2-yd. Page bucket.
1—Complete Caterpillar arrangement for Class 14 Bucyrus Dragline.

1—K-2 Link Belt, gasoline, Shop No. 1068, 50 ft. boom, 1-yd. Page Bucket, steel caterpillars, new 1925.
1—30-B Bucyrus Shop No. 3641, steel caterpillars, 40-ft. boom, 1-yd. Page bucket.
1—Model 210 P&H Gasoline Dragline, Shop No. 1077 Armored caterpillars, 40-ft. boom, 1-yd. Page bucket.
1—Model 21 Marion Gas-Electric, Shop No. 4550, caterpillars, 36-ft. boom, ¾-yd. Page bucket.

CRANES

1—K-2 Link Belt, gasoline, Shop No. 1068, 50-ft. boom, bucket-operating, steel caterpillars, new 1925.
1—Type "B" Erie. Shop No. 559, 36-ft. boom, bucket operating, ¾-yd. clam shell.
1—15-ton Brownhoist 8-wheeled Crane. Shop No. 4520.
1—20 ton Brown Hoist, Shop No. 6583, M.C.B. Trucks, 50 ft. boom, bucket operating.
1—20-ton McMyler, No. 388, 50-ft. boom, bucket-operating.
1—21-ton Industrial 8-wheeled Crane. Shop No. 2706. 50-ft. boom, bucket operating.
1—Type "B" 23-ton McMyler, Shop No. 3265, MCB trucks, 50-ft. boom, bucket-operating.
1—30-ton Industrial 8-wheeled MCB type. Shop No. 3261. 55-ft. boom with 20-ft. extension, bucket-operating.

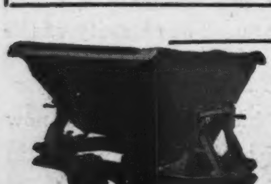
BUCKETS

1—¾-yd. Lakewood clam shell.
1—1¼-yd. O. & S. Clam Shell.
1—1-yd. Blaw-Knox Dreadnaught.
1—1-yd. Class "M" Page Dragline Bucket.
1—1½-yd. Brownhoist Clam Shell.
1—1½-yd. Mead-Morrison Clam Shell.
1—1-yd. Browning, Digging Type with teeth.
2—1½-yd. Page Dragline Buckets.

MISCELLANEOUS

10—50 ft. Camp Cars.
1—Standard gauge Nordberg Track Shifter, gasoline operated.
1—10-ton Austin 3-wheeled Gaso. Roller.
1—60-ton Lidgerwood Unloader with side plows.
1—No. 7-S Knickerbocker Concrete Mixer. with power loader and water tank on trucks. New.
1—American Railroad Ditcher No. 459.
1—8-ft. Austin Giant Road Grader.
1—6½x10 D.C., D.D. American Hoist. with butt strapped boiler.

CLAPP, RILEY & HALL EQUIPMENT CO., 14 No. Clinton St., Chicago, Ill.
BECK, RILEY & HALL EQUIPMENT CO., 458 Union Trust Bldg., Pittsburgh, Pa.



100—NEW V-DUMP CARS

1½ & 1 cu. yd. x 24 in. and 36 in. Gage
Immediate Shipment
Quick to Move—Attractive Prices

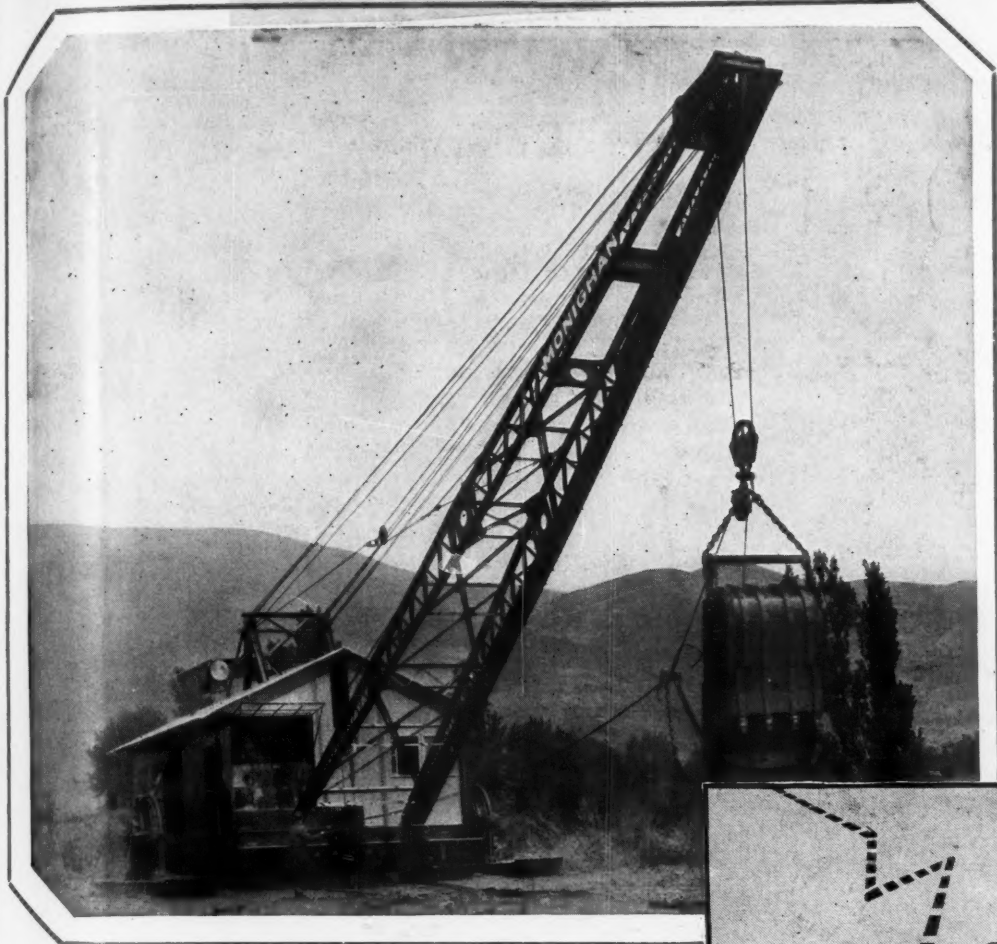
Also New and Relaying Rails—Portable Track

New York City Park Row Bldg. **M. K. FRANK** **Pittsburgh, Pa. Union Trust Bldg.**

FOR SALE

1—No. 5 Telsmith crusher, late type. Used on one road job 23,000 yds. Practically new $1600.00.
10—Western Rock Dump Carts, steel lined, with harness. Pratically new. $45.00 each.
1—3-ton Plymouth Gasoline Locomotive and 6 2-yd. Koppel 36 in. gauge side dump cars. 90% new. All for $1200.00.
1—Portable Schram Compressor. Factory rebuilt. $650.00.

M. WENZEL, 4029 S. Benton, Kansas City, Mo.


MONIGHAN